DOCUMENT RESUME

ED 314 244 SE 051 079

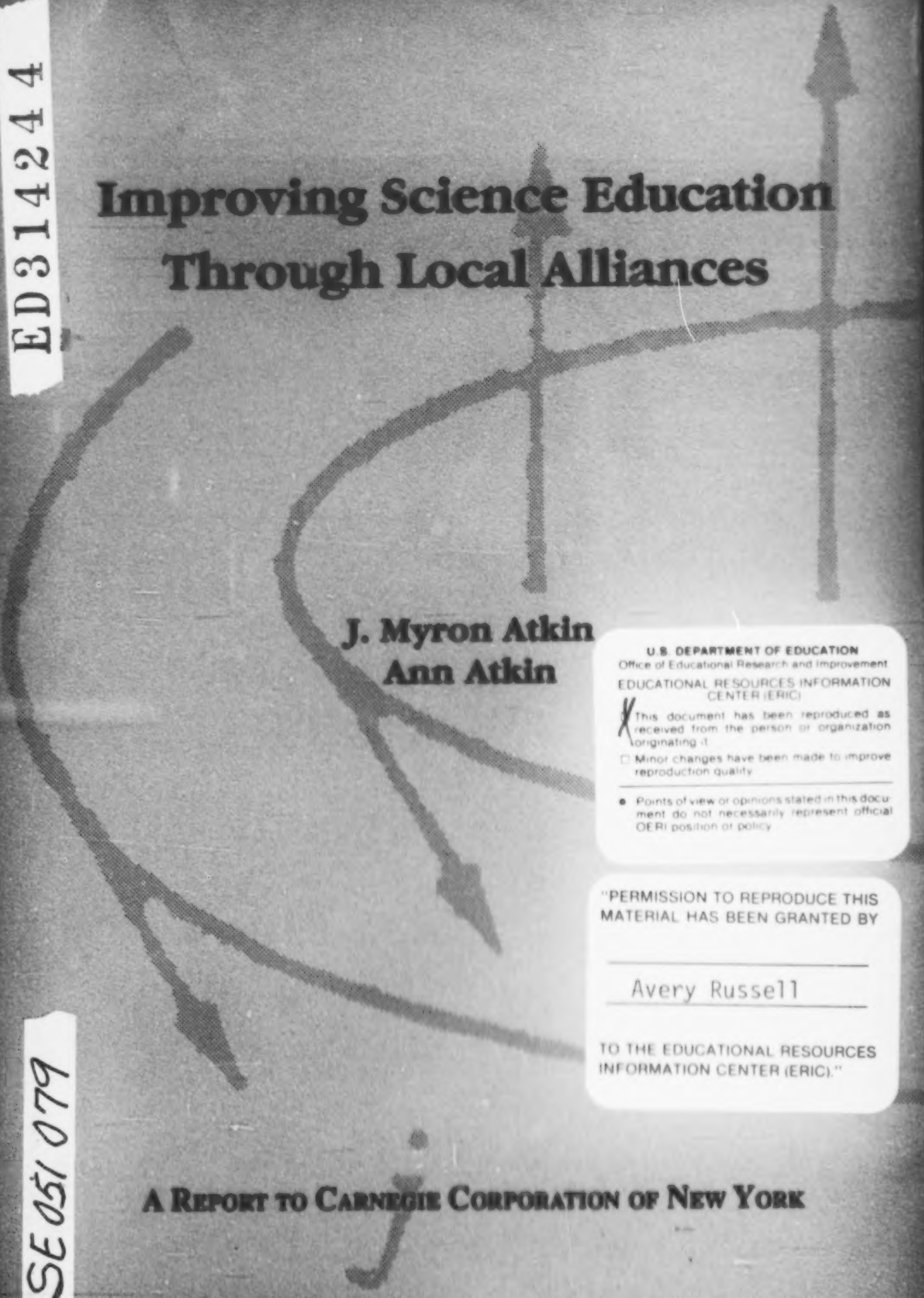
AUTHOR	Atkin, J. Myron; Atkin, Ann
TITLE	Improving Science Education through Local Alliances. A Report to Carnegie Corporation of New York.
SPONS AGENCY	Carnegie Corp. of New York, N.Y.
REPORT NO	ISBN-0-941816-86-9
PUB DATE	89
NOTE	175p.
AVAILABLE FROM	Network Publications, P.O. Box 1830, Santa Cruz, CA 95061-1830 ($10.00, contact for quantity price).
PUB TYPE	Reports - Evaluative/Feasibility (142)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	*College School Cooperation; Cooperative Programs; *Educational Cooperation; *Elementary School Science; Elementary Secondary Education; Higher Education; Science Curriculum; *Science Education; *Science Programs; Science Teachers; *Secondary School Science

ABSTRACT

Collaborations between public schools and national and corporate laboratories, universities, museums, and other institutions may be a significant force in upgrading science education at the elementary and secondary levels. This report focuses on the new, inter-institutional approaches to the improvement of science education and attempts to assess the importance of the collaboration activities based on case studies of approximately 30 programs. Chapters are: (1) "Improving Science Education, Collaboratively"; (2) "The Corporate World"; (3) "Universities"; (4) "Museums"; (5) "'Third-Party' Agencies: Brokers for Change"; (6) "When a School District Takes the Lead"; (7) "Problem 1: Will the Alliances Last?"; (8) "Problem 2: What Science Should Be Taught?"; (9) "What Works: Practices and Policies That Promote Science Education Partnerships"; and (10) "Postscript: Are the Times Different for Educational Change?" The report concludes that educational partnerships could become a more significant force in modernizing science education but their replication and expansion are currently hampered by the lack of a guiding vision of good science teaching and by their marginal impact on the mainstream science curriculum. The report warns that without a substantial commitment to sustained funding by the large national foundations, states, and the Federal Government, the local alliance movement could fall well short of its potential. (YP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED314244



Improving Science Education Through Local Alliances

J. Myron Atkin
Ann Atkin

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☒ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
● Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

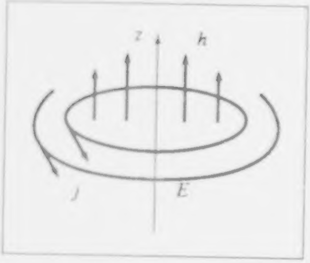
"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Avery Russell
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

A Report to Carnegie Corporation of New York

SE 051 079

BEST COPY AVAILABLE

Improving Science Education Through Local Alliances



Improving Science Education Through Local Alliances

J. Myron Atkin
Ann Atkin

A Report to Carnegie Corporation of New York

Network Publications, a division of ETR Associates
Santa Cruz, CA · 1989

This book was made possible by a grant from Carnegie Corporation of New York. The opinions expressed are those of the authors and do not necessarily reflect those of Carnegie Corporation of New York.

© 1989 by Carnegie Corporation of New York. All rights reserved.
Published by Network Publications, P.O. Box 1830, Santa Cruz, CA 95061-1830.

Printed in the United States of America.

10 9 8 7 6 5 4 3 2 1

Cover design: Lance Sprague
Manuscript design: John Rodriguez and Lance Sprague
Illustrations: John Rodriguez

Title No. 504

ISBN 0-941816-86-9

· CONTENTS ·

Acknowledgments ix
Foreword xi

Introduction 1
Our Bias

1. Improving Science Education, Collaboratively 7
Why Science? Why Now?
A New Commitment
Everyone's Responsibility: Sharing Resources to Improve Education
Who Drives Local Collaboration?

2. The Corporate World 17
Creating an Aerospace Magnet School
Getting Help
Scientist/Teacher Partnerships
Loan Programs
Second Career and Early Retirement Programs
Why Is the Corporate World Involved?
Corporate Interest in Education—Then and Now
Corporate Citizenship
Private Money and Public Schools

3. Universities 45
Getting Universities to Work with Schools
Public Service
Academic Alliances
Partnership Pairs at Universities
MESA
A Consortium in California

4. Museums 65
- Camping In
- Showing a Different Face of Science
- "Museum to Go"
- Institutes for Teachers
- Some Dilemmas for Science Museums

5. "Third-Party" Agencies: Brokers for Change 75
- The Colorado Alliance for Science
- Education Funds
  - An Elementary Magnet-School for Science
  - Teaching Science to First Graders in East Los Angeles
- Teachers Teaching Teachers
- Linking Community-Based Organizations

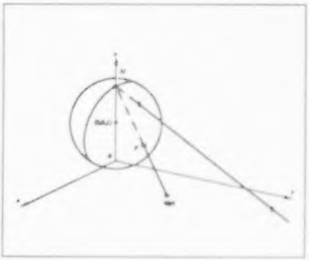
6. When a School District Takes the Lead 97
- The Pittsburgh Science Institute

7. Problem 1: Will the Alliances Last? 105
- Grass Roots and Greener Grass
- Permanent Volunteerism?
- Can Schools Depend on Education Funds?
- Can Collaboratives Depend on the Foundations?
- Can Schools Depend on Universities?
- The Special Case of Schools and Colleges of Education
- Economic Competitiveness as a Driving Force: The Whole Story?
- Fragile, But the Movement Grows

8. Problem 2: What Science Should Be Taught? 125
- Marginal Science
- The Need for Science Leadership
- All Dressed Up and No Place to Go

9. What Works: Practices and Policies that Promote Science Education Partnerships 135
A "Bottom-Up" Strategy
Some Lessons from Successful Partnerships

10. Postscript: Are the Times Different for Educational Change? 151


N
O
P

ACKNOWLEDGMENTS

The study reported here is about collaborative efforts to improve science education. Fittingly, the report itself could not have been written without the unstinting cooperation of many people.

Our greatest debt is to the scores of classroom teachers and school administrators who accorded us the opportunity to observe in classes and talk with children. At every turn, we benefited not only from their hospitality, but also from their heartening willingness to discuss their programs, candidly. We are grateful, also, to a host of professors, corporate leaders, bench scientists in industry, museum professionals, and university administrators who found the time to tutor us about the nature of their own involvement in partnership programs to improve science education in elementary and secondary schools, including their views of the difficult problems of launching and sustaining those programs. Many of the people with whom we spoke are named and quoted in the report. Our gratitude is no less profound to those who are not.

Our research assistant, Steve Schneider, was helpful in dozens of essential ways, but we benefited particularly from his years of experience as a science teacher and his insights into factors that propel both people and organizations to work with one another.

Several friends and colleagues—Larry Cuban, Alden Dunham, Karin Egan, Elliot Eisner, Mary Kiely, Bruce King, and Leslie Siskin—read and commented upon an early draft. Their opinions did not cancel one another out, however, and so all their suggestions had to be taken seriously; many found their way into the final version. We are grateful for their careful reading and insights, though we alone bear responsibility for the result.

Finally, it is important to us to emphasize that we could not visit all the excellent collaborative programs to improve science education that we heard about and that we know exist. Furthermore, we do not even fully describe the programs we did see. We apologize, in particular, to the people who gave so generously of their time in response to our many inquiries if they find less information here than they would wish about their own projects.

J. Myron Atkin
School of Education, Stanford University
Ann Atkin

January 1989

· FOREWORD ·

A study of science education published early in 1989 compared a large number of students from the United States with those from a variety of other nations—all economic competitors. On almost all measures of knowledge and skill in mathematics and science, the American students were at or near the bottom—yet again!

Is this an academic oddity or does it really matter? Surely it does matter, because the world is rapidly being transformed by science and technology in ways that have profound significance for our economic well-being. One upshot of this world transformation is that the work of the future will require much technical competence and flexibility, adaptability to an evolving body of knowledge, and new opportunities calling for periodically updated skills. Effective participation in a technically based and interdependent world economy will require that we have a more skillful and adaptable population than ever before.

Are there practical changes that could rapidly improve the foundations of science education in elementary and secondary schools? Such improvement will be essential on a wide scale and a continuing basis for any modern, technically based economy. Moreover, informed participation in the decision-making processes of a democratic society will increasingly require a basis in general education for understanding scientific concepts. So, the educational requirements for the next century will be very different from those that prevail now.

Any serious inquiry into education reform must recognize the centrality of teaching. A few years ago, a study sponsored by the American Association for the Advancement of Science compared pre-collegiate science education in this country with its counterpart in the two Germanys, the Soviet Union, China and Japan. Two main findings were: (1) students generally are more advanced in pre-collegiate science in those countries than in the United States; and, (2) the status of teachers is considerably higher in these other countries than in our own.

If we are serious about fundamental, long-term upgrading of American education, we must find ways to strengthen the capability and effectiveness of teachers. In practice, this will mean a truly major national effort to enhance teaching as a profession—a broad, multi-faceted effort, not a singly flashy gimmick or a rapid magic bullet. Such an effort will involve: (1) attracting very able people; (2) providing them with a substantial education in a particular subject matter as well as the principles of human learning and their applications; (3) means of demonstrating their competence and maintaining it in ways that manifestly help students and thereby earn public respect; (4) clear social and economic rewards—respect and income—consistent with a highly valued profession; (5) opportunities for professional development throughout the entire span of a career; (6) a working environment that is conducive to active learning and mutual respect; and (7) a structure of opportunity that makes it possible for the profession to reflect the full diversity of our nation.

In 1983, Carnegie Corporation assessed the status of science education and saw some opportunities for improvement. We were struck by the discrepancy between our science-rich sector—e.g., universities, national laboratories, and corporate laboratories—on the one hand, and the science-poor sector on the other. Sadly, almost all elementary schools and the vast majority of secondary schools fall into the science-poor category. Therefore, we set out to strengthen mechanisms to link the scientific assets of universities, colleges, corporate laboratories, national laboratories, and museums, with the elementary and secondary schools—thereby strengthening national capability for education in the sciences: physical, biological, behavioral. There are many opportunities for involving precollegiate science teachers with the science-rich sectors of our society. School teachers must have good reason to feel that they are an integral part of an extraordinary scientific enterprise if they are to convey to their students the zest and adventure of science.

Such collaborations can be an important step in the general direction of incorporating teachers of science into the scientific community. These linkages include summer institutes for teachers, Saturday activities for teachers throughout the school year, summer jobs in science for teachers, and the preparation of curricular materials by collaborative groups of leading scientists and practicing teachers. The schools are central to the effort of modernizing science education but they alone do not have the resources or the clout to do the job that needs doing.

Carnegie Corporation has made a variety of grants in the intervening years to create or strengthen such partnerships. Some explorations took us into unexpected paths and opened unforeseen opportunities. Others led to stimulating and cooperative activities regarding partnerships without Carnegie grants. The grants involved several categories: local science alliances or collaboratives; colleges and universities in relation to the schools; science museums; business community and schools; statewide, regional, or national partnership programs.

These explicit partnerships do not by any means exhaust the opportunities for linking the science-rich and science-poor sectors. But they do constitute a reasonably coherent set of ideas and operations involving a lot of innovation and promise. We therefore felt the need for an assessment of the national experience with such partnerships and sought a wise, well-informed person to conduct it. We were very fortunate to enlist the cooperation of Professor Myron Atkin of Stanford University, a distinguished science educator and former dean of Stanford's school of education. In collaboration with Ann Atkin, a careful look at these alliances was undertaken. Their extensive background knowledge, visits to the partnerships, interviews and observations involving multiple perspectives, and thoughtful reflections give the nation a solid basis for building on the experience of the Carnegie-supported alliances.

The lessons learned are cogently stated. Moreover, these lessons are treated with foresight. Doors are opened to additional possibilities for fruitfully linking science-rich and science-poor sectors. For example, the text touches on two other Carnegie-supported projects of great promise: (1) the AAAS Project 2061 in which representatives of the entire scientific community have pulled together the essential concepts of science and technology across the board in a form useful for elementary and secondary education; (2) the Stanford Human Biology Project on Life Sciences for the Middle Grades, in which a distinctive curriculum is being developed for early adolescents, integrating biological and behavioral sciences in a way that is likely to capture the interest of these students. Both of these projects are characterized by features of great promise: (1) the leadership of outstanding scientists; (2) collaboration of the scientists with practicing science teachers from schools across the nation; (3) an orientation to the natural curiosity of students and ways to stimulate that precious outlook; and (4) the development of critical thinking skills and constructive problem-solving abilities.

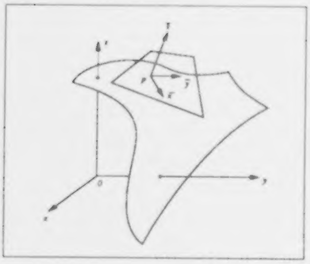
Of the many ingenious joint efforts, and the possibilities for new combinations, two kinds of partnerships stand out in my mind for their future potential: links of schools with (a) colleges and universities, and (b) businesses and the corporate community. Both center on institutions of considerable strength that are richly distributed across the nation; many linkages with the schools are possible.

With respect to colleges and universities, there is in principle a natural affinity since they are all educational institutions: from kindergarten through graduate school they provide a continuum of education. Indeed, a Carnegie-supported project of the American Association for Higher Education has elicited a public commitment from several hundred college and university presidents to find ways of linking their institutions with the schools. The presidents are providing personal leadership, especially in strengthening the teaching profession, involving both pre-service and in-service education. This effort has particular significance for disadvantaged minorities.

With respect to the business community, a variety of arrangements may be beneficial. There are direct contributions of business such as corporate laboratory participation in science education, making skilled personnel available to work part-time with the schools, and making financial contributions. Indirect contributions may be even more important in the long run such as raising the status and resources of the schools via community advocacy and political support for education.

So there are many paths to linkage of science-rich and science-poor sectors, and many forms of partnership. Indeed, other foundations are supporting similar work in the humanities with similar encouraging results. The theme of alliance for education has many interesting variations. Altogether, this line of innovation gives us one basis for hope that the next century will see a quality of education on a widely inclusive basis that will exceed anything so far achieved.

David A. Hamburg, M.D.
President
Carnegie Corporation of New York


$\bar{z}$
z
P
$\bar{y}$
$\bar{x}$
0
y
x

1

· INTRODUCTION ·

The study reported here focuses on the new, inter-institutional approaches to the improvement of science education in grades kindergarten through twelve that have surfaced during the past decade: the "alliances," "partnerships," and "collaboratives" that have been created for the purpose of linking public schools more closely to industry, universities, and other institutions, with the aim of reinvigorating science teaching. This report also attempts to assess the importance of these activities, and indicate how they might develop in the years immediately ahead.

This examination of collaboration among different agencies to improve science education was undertaken at the request of Carnegie Corporation of New York. Carnegie conducts a program titled "Education: Science, Technology, and the Economy," a part of which has developed into a series of grants to encourage "science-rich" institutions to share resources with the public schools. In the words of Carnegie president David Hamburg at the outset of the program, "Opportunities will be sought to connect the scientific talent and skill of universities, corporate laboratories, and national laboratories with the elementary and secondary schools, thereby strengthening national capability for education in the physical, biological, and behavioral sciences." [1]

Since 1984, Carnegie has awarded twenty grants for this purpose, totaling about $8.3 million. The Ford Foundation

---

1. David A. Hamburg, "The Context for Carnegie Corporation's New Grant Programs." Carnegie Corporation 1983 Annual Report. New York: Carnegie Corporation, 1983.

has conducted a similar program to improve mathematics education. The Rockefeller Foundation supports collaborative efforts in the humanities and arts.[2] Almost all the grants from these three foundations have been directed toward mid- to large-city schools with relatively high proportions of poor and minority-group students—places like Cleveland, Atlanta, Pittsburgh, San Francisco, Philadelphia, San Antonio, and Los Angeles.

The two of us were asked to help evaluate the Carnegie program. What is happening in the various collaborative ventures as a result of the grants? What might be the long-term impact of these activities? How might the Carnegie program—and the collaborative efforts themselves—be improved?

However, as discussions progressed with Carnegie staff, and as our work in the various cities got under way preliminarily in 1987, the aim of the study gradually shifted and expanded. We decided to attempt a somewhat more extensive look at cooperative activities to improve science education, and not confine ourselves or the study to the communities in which Carnegie had awarded grants.

The reason? Collaboration between school districts and other agencies seems to have assumed the proportions of a major educational movement. One hears considerable discussion at a national level about the importance of "public-private" ventures and "inter-sectoral" cooperation in all spheres of social policy. Action programs based on such strategies are suggested for attacking a range of domestic problems—from housing, to services for the indigent elderly, to the incarceration of convicted criminals, to the management of natural resources.

---

[2] For a report on the Rockefeller Foundation collaborative programs, see Gene I. Maeroff, THE EMPOWERMENT OF TEACHERS: Overcoming the Crisis of Confidence. New York: Teachers College Press, 1988.

"Partnerships," "alliances," "cooperatives," and "collaboratives" are among the new watchwords on the educational policy and innovation scene. Novel and improvised relationships are being forged between schools and other agencies, public and private, on almost a weekly basis. John Fowler, Director of the Triangle Coalition, a unit of the Washington-based National Science Teachers' Association that tries to monitor, stimulate, and provide technical assistance to those building cooperative programs in science education, reports that the Coalition had documented the establishment of 250 local alliances by mid-summer, 1988. Greg Crosby of the Coalition estimates that there are an additional 250 that have not yet come to the Coalition's attention, with the number increasing steadily.

The questions we address in the study include the following: What does collaboration to improve science education look like? Who is involved, and what do they do? What is the special role of "third-party" agencies, particularly the local education funds, that were created specifically to promote collaboration in education? What benefits do the partnerships, alliances, or collaboratives hold for teachers? For children? For school administrators? For those in the corporate world who become involved? For university professors and presidents?

Most importantly, are the cooperative programs a significant force in the total science education picture today, or are they a relatively minor and strictly local phenomenon? Are they likely to be ephemeral, or will they be around for a while? If they last, how are they likely to evolve in the years ahead? Would it be sound public policy to try to sustain and expand these activities? If the answer is affirmative, what does it take to start them and keep them going?

Our Bias

By the time the study was completed in late 1988, we had undertaken relatively brief visits (each from two to five days) to about thirty sites with strong reputations for the quality of inter-institutional cooperation to improve science education. About twenty of these programs had been receiving support from Carnegie Corporation.

Clearly, then, we did not select a representative group of collaborative programs. Far from it. Carnegie had awarded grants only to those ventures that seemed to represent the best examples of cooperation available. The others we decided to visit also have a reputation for high quality. Furthermore, we tended to observe and talk with the teachers and administrators who were most willing to try something new, tolerate observers in their schools and classrooms, and discuss their professional lives with strangers. These teachers and school principals did not always have strong science backgrounds, but they are the kinds of people with enough confidence in themselves to have altered some of the practices that they had employed (sometimes for decades), and reflect on the consequences. Therefore, the activities we describe and the recommendations we proffer are based on the very best instances of public school cooperation with other institutions to improve science education that we could find the time to visit.

Partly as a result, but in a fashion that surprised us, we developed a strong, positive view of the partnership programs early in our series of visits. It became obvious almost immediately that unusually energetic and able men and women, who know their communities and their children, and who are adroit politically, are the ones responsible for forging new links between the schools and other agencies. The positive picture we formed was developed early in the study. That fact is reflected in this report—and helped to shape it.

Not only are skillful people in charge at every one of the places we visited, but virtually all of the participants with whom we spoke are enthusiastic. Each one is deeply committed to the improvement of the education of young people, and most are very able. The impact of these programs on the children they touch is heartening; the collaborative work we saw generates a spirit of purposefulness and optimism among teachers that has been rare in American schools in the last two decades, particularly in urban communities.

Nevertheless, even if we cannot now claim to be dispassionate about inter-institutional activities to improve science education, we hope the reader of this report will find useful descriptions, defensible analysis, and suggestive recommendations. Though we developed deep respect for most of the people we met, grew fond of many of them, and came to care deeply about the programs they have shaped, we do not consider ourselves innocent about what it takes to have a high-quality program of science education, or about the complex and vexing problems of educational change.

We are mindful, also, that we have become advocates for programs that are only a minor feature of the educational landscape with respect to scale. From most policy perspectives, at this moment, collaboration is a novel and interesting sidelight; despite the large and growing number of such programs, not much money is spent for collaboration between schools and other agencies, compared with total educational expenditure. It is not a major focus for governmentally stimulated science-education reform just now (though government is not entirely absent).

Moreover, there are serious problems in launching and sustaining educational partnerships. In many ways, even the admirable sets of relationships we saw are intricate and fragile, and, unsurprisingly, they are of greatest benefit to those children fortunate enough to come in contact with teachers and school administrators who have the initiative and confidence to try to capitalize on new opportunities.

Finally, and of central importance, we were not always sure that the collaborative activities were channeling their impressive energies into the most worthy or promising targets for improving science in the schools—or even, in a few cases, that the specific focus for the programs had been carefully considered at all.

We try to address these issues, and other troublesome ones, besides. Despite our advocacy, then, this report not only highlights the successes, but also the limitations and problems that seem to be associated with attempting to strengthen science education by encouraging different kinds of institutions to work with one another.

· 1 ·

IMPROVING SCIENCE EDUCATION, COLLABORATIVELY

Americans are worried about their schools. They are upset about students' reading-comprehension and college-admissions scores. They are concerned about the qualifications of the teachers. They are incredulous and angry about the geography and history that aren't taught. They are distressed about school discipline and drop-out rates. Amidst the drumbeat of criticism and frustration, the questionable quality of the contry's science education receives plenty of attention.

A major international study published in 1988 revealed that American students at fifth-grade level ranked 8th among children from 15 countries in science. At ninth grade, the United States was 15th in a field of 17. For top-achieving high-school students in biology, the elite "advanced placement" group, the U.S. was last. Advanced chemistry students were 11th out of 13.[3]

Systematic and intensive classroom observations commissioned by the National Science Foundation ten years ago (and that still offer the best available picture of American science teaching) suggest that most instruction in science is lackluster, at best.[4] The science lesson too often is a vocabulary exercise, with children reciting back to the teacher what the text says, preferably in the exact words, then memorizing the definitions. In only a small fraction of classrooms is there first-hand experience to supplement the written word, student-conducted experiments, and active investigation of puzzles and problems in the natural world.

---

[3] International Association for the Evaluation of Educational Achievement, SCIENCE ACHIEVEMENT IN SEVENTEEN COUNTRIES: A PRELIMINARY REPORT. Oxford: Pergamon Press, 1988.

Why Science? Why Now?

Why the special public concern about science, since Americans read about many other shortcomings of the schools as well? The reason heard most often is that American industrial productivity compares poorly with that of other nations; consequently its international trade position is jeopardized. A key factor in improving productivity, the country is told, is a better-educated work force, especially in technical fields, including science.

While the role of education in improving the nation's economy is unquestionably the reason for the burst of public attention to public elementary and secondary schools in the late 1980s, there are additional reasons for a special focus on science. For those who will be employed in technical fields, education in science must start at ever-younger ages and continue for a longer period of time; it is increasingly difficult to choose a science specialization at the conclusion of a program of secondary education (or later in life) because of the mathematical and scientific prerequisites for college-level courses and other forms of advanced training. A basic grounding in science must be established during the years of compulsory schooling, if it is to be established at all for occupational purposes.

---

[4] Robert Stake and Jack Easley, CASE STUDIES IN SCIENCE EDUCATION. Urbana, IL: University of Illinois Center for Instructional Research and Curriculum Evaluation, 1978.

For all the others—the majority of the people in any society who do not work in a scientifically based job—it is becoming increasingly important to understand developments in science to make informed decisions about the more ordinary aspects of daily life. How does one choose a healthful diet in the light of competing claims and proliferating fads? How is one to evaluate the evidence about tobacco smoking? What about one's sexual behavior in the light of research on AIDS? On what basis does a person glean meaning from advertising and labeling to select ordinary household products like TV sets, soaps, or detergent? How does quantification of the concept of "risk" affect mundane and complex decisions—from choosing to drive a car above speed limits to determining whether or not a municipality should permit transportation of potentially hazardous material on the nearby rail line? While technical information is not the sole factor in guiding such decisions, the nature of the problems make it necessary, at some non-trivial level, to know how to deal with the underlying scientific content.

In addition, there is the even more profound issue of a sense of personal efficacy that underlies these kinds of choices. A significant and apparently growing number of people feel that they have little influence over their own lives, that complex, distant, powerful, and incomprehensible forces constrain their own scope for individual and independent action; they have little or no control over their own fate.[5]

While studies in many subjects (arts, history, literature, geography, and psychology, for example) lessen feelings of unpredictability and alienation in an intricate and interconnected universe, a strong program of science education can help young people feel more at-home in the natural and human-created worlds, enabling them better to understand the range and power of their own capabilities in making these worlds safer and more productive. Science, and a strong program of science education, can help people grasp fundamental concepts like causality, chance, predictability, and randomness as do few other subject fields. Educational goals associated with self-efficacy are particularly important in democracies, where it is a basic article of political faith that people have the capacity to act on their own behalf.

---

[5] See, for example, Mary Budd Rowe, "Science Education: A Framework for Decision-Makers." *Daedalus*, Spring 1983, Vol. 112, No. 2, pp. 123–142.

A not insignificant number of people consider scientific research and technological development to be vaguely or explicitly sinister. Experiments on alteration of genetic material are disquieting to some, the motives of the researchers often unclear or suspect. Animal-rights groups have become more influential in the last decade. While advocates of handling animals more humanely have often raised important questions about laboratory conditions and the necessity of certain experiments, some of the organizations seem hostile to any medical research that entails experiments with mammals—especially large ones. Not far below the surface of some of the vocal protests to the use of animals in medical research is a deep antipathy and distrust of science itself.

A strong science education program can help students sort fact from myth, and put them in a better position to react to such groups than to depend solely on headlines and television reports.

Additionally, as the world becomes more crowded, polluted, and endangered by nuclear and other weapons, the challenge of leaving an inhabitable world for the generations to come becomes a societal question that is driven ever-more strongly by scientific and technical considerations. A sense of stewardship for the planet among the population at large is becoming essential for survival of the human species—for survival, at least, in a setting that those who are adults today in the industrialized world have come to expect.

Finally, and far from least important, science is one of the crowning achievements of human intelligence. Its study demonstrates the power of rational thought in understanding common and complex phenomena—from how sound travels, to how the body fights disease, to the principles that govern space flight, to how human traits are transmitted from parent to child, and, of course, much, much more.

Just as children learn great literature partly to gain insight into human feelings and action, and history to learn how a society's institutions have developed over the centuries, they can study science to gain an appreciation of how people have explained the biological and physical world of which they are a part. Science, as an invention of human beings, deserves serious study in any well-conceived program of general or liberal education. Indeed, to live minimally thoughtful lives, as well as to cope directly with scientifically based developments, young people now in school—who will live their lives mostly in the 21st century—need a carefully considered and strong program of science education.

A New Commitment

There are plenty of signs that the country is ready to take steps to improve science teaching. The Congress has more than doubled appropriations to the federally funded National Science Foundation for improvement of science education since 1983. Annually and forcefully, it has provided more funds than the Administration requested for this purpose, even surpassing the increases for Foundation-supported basic research in science. Most states are revising their science requirements for elementary and secondary schools. Several are demanding that publishers provide more rigorous and challenging textbooks, and all of them are seeking means of educating and attracting better-qualified science teachers.

The American Association for the Advancement of

Science is sponsoring a multi-million dollar effort, Project 2061, to identify the science facts and concepts people should understand by the time they are eighteen years old; it is the largest educational effort ever undertaken by the Association.

Not since the 1960s, in fact, has America heard as much as it hears today about the need to improve the quality of science teaching, or tried to do so much about it. Then, the attempts to create dozens of courses in science and mathematics for elementary and secondary schools, and prepare teachers to handle the new content, was spurred by Sputnik. The nation was determined to catch up in the space race, and better science education was seen as playing a key role. As a result of initiatives launched at that time, marked improvements were effected in elementary and secondary schools (though not all the problems were solved, and many of the changes were not permanent). Now, the major impetus for improvement of science education seems to be to reinvigorate the American economy, but, once more, science education is seen as a critical factor in reaching an important national goal.

Everyone's Responsibility: Sharing Resources to Improve Education

The education-improvement scene in science in the late 1980s is not only vigorous, but varied. In addition to the very active state and federal authorities, the professional associations, like the National Science Teachers Association are initiating programs. So are the two teacher unions, the National Education Association and the American Federation of Teachers. So are most states and many municipalities: New courses are being developed. Teachers are being educated and re-educated. More experiments are being funded and demonstration projects established to learn better ways to teach science.

But there is also something quite new as the decade nears its end, at least in scale: In a fashion not apparent in the 1960s, and at an accelerating rate, the corporate world is becoming engaged in the serious business of improving schools. This involvement by industry goes beyond the alternation between scolding and exhortation that often has characterized corporate concern about education in the past. It extends to cooperative initiatives in which corporations join with school districts to make changes, and, in the process and most importantly, develop a stake in the outcome.

Other institutions traditionally disassociated from science programs within primary and secondary schools are also entering into joint ventures that put them in close connection with public-school districts to improve science teaching. University professors, for a hundred years, have concerned themselves sporadically with education below the college level, but now they are moving toward relationships with the school teachers and administrators that are impressively more collegial than those of the past. Science museums are revising their programs better to serve teachers and children. So are certain units of the Army, Air Force, and Navy, all technologically strong agencies that have high proportions of skilled personnel, who might be helpful as schools try to update and expand their science programs.

Schools do not have abundant science resources. If they are fortunate, they have well-prepared science teachers. But, even in this dimension, about one-third of the science teachers in the country—and 50 per cent of those newly assigned to science classes—are teaching out of their area of training (teachers prepared in biology are teaching physics, for example). [6] Very few schools have adequate laboratories or equipment for the job expected of them, and most districts lack up-to-date books in sufficient quantity for high-quality education. In only a tiny number of high schools is there an adequate supply of scientific journals.

---

[6] Estimate in mid-1988 by Bill G. Aldridge, Executive Director of the National Science Teachers Association.

Certain corporations and all universities and museums, on the other hand, are "science-rich" by comparison. A purpose, though not the only purpose, of the cooperative activities that provide the focus for this report is to make it possible for such institutions to channel some of their resources to the public schools.

Who Drives Local Collaboration?

Locally inspired efforts to improve education are not unprecedented in the history of education. What seems novel, however, is the fact that one particular kind of local initiative—the inter-institutional alliance—has become ubiquitous. That fact, and the attempt to understand it, are the sole reasons for this report.

As we have said, there are now several hundred partnership programs around the country in science alone. We therefore consider them to represent a significant educational movement.[7]

Each local alliance is different. Some involve universities; others do not. A few enjoy a dependable level of state appropriations; most face serious fund-raising problems continuously. In some communities, a "third-party" agency paves the way for collaboration and institutional commitment;

---

[7] We must continue to stress that their scale is not large when compared with the total investment in education. Jeannie Oakes of the Rand Corporation (in "Improving Inner-City Schools: Current Directions in Urban District Reform." Center for Policy Research in Education, 1987) estimates that, in 1982 and 1984, "business relationships typically contributed only one-half of 1 per cent of districts' budgets." Universities probably do not contribute more, nor do museums or other agencies. On the other hand, it is difficult to quantify "in-kind" contributions by scientists and others (as contrasted with cash). Furthermore, involvement in the schools has increased since the early 1980s.

elsewhere, it is a particular corporate officer, university president, or superintendent of schools.

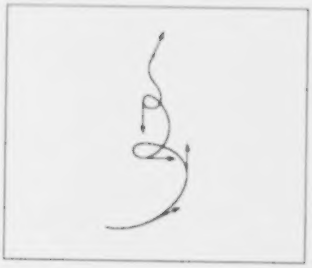
We have chosen to organize the next few chapters of the report to highlight the contributions of different types of institutions to today's collaboratives: the corporate world, universities, museums, and third-party agencies. As with many classification schemes, categorization can be misleading. In the best collaborative efforts, and we saw very good ones, there is not a sharp delineation of responsibility among the partners, nor a clear, single source of good ideas. Even when one institution seems unquestionably to provide the driving force for the program, at least initially, all the participants quickly develop a stake in the enterprise; otherwise the alliance is unlikely to be successful.

Nevertheless, it is the nature of inter-*institutional* collaboration that makes these activities so special. Therefore, the focus on institutional roles seems appropriate and potentially useful as a way of trying to figure out what is going on, where some of the problems lie, how they might be overcome or mitigated, and the steps that might be taken to enhance the beneficial effects of the programs.

In particular, the examination of the programs from the perspective of each type of participating institution offers a framework for understanding the motivation of the participants, as well as the problems. It is in the motivation, we believe, that one finds the seeds for policies that create the greatest likelihood of success in enhancing the climate for collaboration to improve education.

Following the description and analysis of the role of different institutions in the alliances we visited, two chapters are devoted to the major problems that we believe the collaborative movement must face and overcome: the fragility of the local partnerships and the quality of the science that many of them try to promote. Unless these difficult issues are recognized and ameliorated, we believe the movement will fall short of the beneficial effect it might have on the educational system (and that we think it should have).

3.



· 2 ·

THE CORPORATE WORLD

Corporate involvement in efforts to improve elementary and secondary education is found in every region of the country. While the scale of such activity, viewed nationally, pales in comparison with the total effort in pre-collegiate public education, it is nonetheless intense at many of the places where it does exist, and visible in every state.

The Westinghouse Corporation has adopted the George Westinghouse High School in Pittsburgh. Westinghouse provides equipment; some of its employees come to the high school to talk with students and teachers. The Aluminum Corporation of America (ALCOA), headquartered in Pittsburgh like Westinghouse, has adopted the Allderdice High School. Science teachers at Allderdice have access to the ALCOA library. Twenty-five ALCOA employees—from attorneys, to public-relations specialists, to foreign-language translators, to truck drivers, to secretaries, to engineers—participated in a recent day-long Career Day at the school designed to highlight employment possibilities. In the course of the program, it became clearer to many students how their work in high school relates to jobs they will have later.

The Sun Company, with corporate headquarters in Philadelphia, provides valuable office space and other resources to the Philadelphia Renaissance in Science and Mathematics (PRISM), a collaborative activity that helps to coordinate participation by industry and other agencies in the improvement of science education in the School District of Philadelphia. More than thirty corporations participate in

PRISM, firms like Mellon Bank, CIGNA, Bell Atlantic, SmithKline French Laboratories, the Budd Company, ARCO Chemical, the Hunt Manufacturing Company, and Rohm and Haas.

PRISM conducts a range of activities, including a "mini-grant" program that provides up to $300 to a single teacher or up to $3000 for a group project to improve science teaching, an institute program that offers graduate-level instruction, and a "Philadelphia Teachers in Industry Program" (PTIP) that includes a nine-month fellowship. A fellow begins by working for a summer in one of the host corporations, then moves on to develop materials for use with students. The PTIP provides a stipend to each teacher-fellow approximately equal to what the participant would earn in summer employment, and up to six semester hours of graduate credit.

Creating an Aerospace Magnet School

Jim Davis is the third-year Principal of Westchester High School, which is in the Los Angeles Unified School District (LAUSD), about two miles from LAX, the international airport. The neighborhood also houses hundreds of aerospace firms, including some of the largest in the world, like TRW and Hughes Aircraft.

Recently, Westchester High, with a capacity of 2210 students, has been losing about 150 of them each year, and, in 1987-88, dropped to 1842. The enrollment projection for 1989-90 is 1500. During the last seven years, it has also shifted from a student body composed 30 per cent of minority students to one that is now about 70 per cent minority.

To check the student population decline and reverse the accelerating racial isolation, Davis took the lead in developing a proposal to the District's Board of Education to designate Westchester High, along with nearby Orville Wright

Junior High School, as a single aerospace magnet school that would encompass grades six through twelve. "In view of our location, it's a natural," he says.[8]

For several years, the LAUSD has conducted a magnet-school program designed to create attractive educational programs that draw students from a wide geographic region of the metropolis. The impetus for establishing magnet schools, in Los Angeles as in most places, is to promote racial integration in the school district by offering parents and students a good reason to enroll elsewhere than in their neighborhood schools. Racial isolation in Los Angeles, as in most other places, is intimately linked to residential patterns. The incentive to enroll in a school other than the one nearby is the existence of a specialized educational program, unavailable locally, that is sufficiently worthwhile to volunteer to spend a considerable amount of time every school day riding in a bus.

The plan for the Westchester/Wright magnet school that would attract young people from other parts of Los Angeles stipulates that the aerospace theme would be infused throughout the curriculum; almost all courses would be influenced. The science curriculum would make special provision for space biology, aeronautics, and astronomy, for example. Students would study the historical and economic impact of the aerospace industry in their social studies courses. Geography would include an introduction to remote-sensing and the mathematical modeling of dynamic systems, like the atmosphere and hydrosphere. Mathematics would include topics in discrete mathematics, statistics, probability, patterns, and functions.

In business classes, students would learn computer skills and accounting. They might learn about specific aspects of the industry, from the ticket counter, to maintenance, to procurement. Airline and airport employees at all occupational levels would come to school to discuss their work.

---

[8] All direct quotations are taken from personal conversations, unless otherwise noted.

Two foreign languages would be required of all students, both for those who seem headed for college and those who are unlikely to do so. Students interested in aerospace careers would "shadow" aircraft mechanics, flight controllers, travel agents, and many others in nearby industries to learn what their jobs are like. Gradually, students would begin to obtain summer jobs in local firms. "If we want to motivate kids, we have to demonstrate that what happens in classrooms relates to work they'll do later," says Davis.

For all this to happen (indeed, for the concept even to have been outlined as described here), it is essential that the combined Wright Junior High and Westchester High School develop close working relationships with employers at the airport and in the surrounding industries.

There has been a receptive climate in the LAUSD for several years for joint efforts with private and public enterprises. Two of the existing science magnet schools are affiliated with health centers, one at the University of Southern California medical complex, the other at the M.L. King/Drew Hospital. A third science magnet, focusing on animal studies, is at the zoo.

The time seems right for Davis' initiative. Magnet schools elsewhere in the District are successful: they attract students, and parents and teachers seem enthusiastic. Los Angeles also has had an adopt-a-school program for several years, in which scores of firms in the LAUSD have developed special relationships with specific schools—at elementary, junior-high, and high-school levels. Students have become acquainted with the work of the company in these programs. Corporate employees have come to school to describe their jobs. The firms have often donated equipment to the school.

Getting Help

As a necessary preliminary step in securing approval for the proposal, Davis approached the Westchester/LAX Chamber of Commerce to obtain its endorsement and begin securing the broad and detailed cooperation from local firms that would be necessary were the concept to materialize. The Chamber endorsed the concept and extended an enthusiastic offer of support.

Fred Rupp is Manager of the Antenna Systems Lab in the Radar Systems Group at Hughes Aircraft. He also has been the Adopt-A-School coordinator for Hughes Radar. As part of the latter set of responsibilities, he played an important role in Hughes' decision to enter into a special relationship with the nearby Orville Wright Junior High School. At 46, with major and growing professional responsibilities in the company, he devotes about 20 hours each month to working with teachers and administrators in the Los Angeles Unified School District to improve programs of science education.

Rupp's interest is personal, of course, but Hughes Aircraft supports his participation in these activities by making it possible for him to charge some of the time that he spends on school district activities against his company responsibilities; that is, several hours per week of Rupp's effort for the LAUSD are compensated for directly by the company. Hughes also enables him to provide books and a computer to the school at Hughes' expense.

It happens that Hughes Aircraft's corporate offices are in Westchester. Rupp, whom Jim Davis knows, is one of those on whom Davis relies for advice and other forms of assistance. When approval is secured from the LAUSD Board to proceed with planning for the magnet school, Rupp will be one of those with whom the magnet school staff will work closely.

Scientist/Teacher Partnerships

"Target 90—Goals for San Antonio" is a planning effort, initiated by Mayor Cisneros, to identify and mobilize community resources for improvement of San Antonio and the surrounding communities in Behar County, Texas. Education is a key factor in community development, and the San Antonio Science Collaborative was created as part of Target 90. One of the projects in the Collaborative is a "Scientist/Science Teacher Partnership" program that links science teachers at elementary- and high-school levels with scientists in universities, the military (there are several Air Force bases in the area), and industry.

Under the Partnership program, scientists in the community are paired with individual science teachers. The pair decide on the specific projects they want to undertake. Sylvia Bonilla, a first-year chemistry teacher at Harlandale High School, was introduced to Dr. Robert Lyle, Vice-President for the Division of Chemistry and Chemical Engineering at the Southwest Research Institute (SWRI), who had volunteered to participate in the program. SWRI is a large, technically oriented, contract-research firm in San Antonio, with thousands of employees.

To initiate the partnership, Lyle came to two of Bonilla's classes. In one, he demonstrated the generation of toxic gases in the smoke of certain fires, and discussed his research on hazards evaluation in construction materials and home furnishings. The day after one of Lyle's visits, the class visited SWRI. They saw demonstrations, some of them dramatic, like the extremely rapid burning of a natural Christmas tree. They also talked with scientists and technicians at several of SWRI's laboratories. The students had lunch in the company's executive dining room.

The visit to SWRI was conducted the day before Harlandale's spring break. "After the break, they were still talking about their trip," said Bonilla. "Students learned from the technicians that they could get certain jobs [at SWRI] with only a high-school diploma, or maybe an associate degree [a two-year college diploma]." Of great importance to Bonilla was the fact that her students found out that concepts discussed in class are really used in industry.

"Fire technology seemed to be what would interest the Harlandale students most, so that's what we did," said Lyle. "The students were truly interested. I didn't expect them to be so well-behaved. I was surprised, though, that so many of them didn't have very clear goals in mind for what they want to do when they leave school. In the future, we could do lots of other topics. I want the program to continue. Perhaps some of the students can work in our labs. Teachers, too."

Lyle's interest in education is deep and long-standing. He had been a faculty member at the University of New Hampshire for 25 years, and at Oberlin College for two. He is concerned about the relatively small amount of science in the education of most people and sees his participation, and that of his SWRI colleagues, as one tangible route to improvement. "People [at SWRI] are civic-minded enough, and selfish enough, because of their interest in the education of their own children, to want to help."

There is a reciprocal side to the relationship, according to Lyle. "Chemists also want to recruit people for their own specialty, and help people understand it. Unless chemistry can broaden its perspective, there is a real possibility it will disappear as a unique discipline. Fifteen years ago, a researcher was labeled a polymer chemist. Today that person is a 'materials scientist.' Much of bioengineering and some fields of biotechnology are really chemistry. If chemistry is to survive as a distinct discipline, people must begin to understand what chemists do."

The Scientist/Science Teacher Partnership was initiated by Dave Sugg, who heads the San Antonio Science Collaborative for Target 90. Letters of invitation were sent to local members of Sigma Xi (a national honorary society of scientists), chief executive officers of corporations involved in scientific research, and department heads at local colleges and universities.

A parallel letter went from Sugg to teachers selected by science coordinators in four school districts in the immediate San Antonio vicinity. The kick-off event, a dinner meeting at SWRI, attracted 72 teachers and 86 scientists. The scientists were from SWRI, Brooks Air Force Base, the San Antonio Zoo, and several local universities. Thirty-six partnerships were launched almost immediately. Others followed.

Here's how the program was described in a document sent to those who expressed interest:

> . . . In a scientist-teacher partnership, the scientist, by virtue of special knowledge and experience, would serve as a valuable resource for the teacher. The sharing of this knowledge and experience would then be carried back to the classroom by the teacher, thus enhancing science education in the public schools.
>
> Although each partnership would eventually be molded to meet the individual needs of the parties involved, we have developed a model to help begin implementing this program. A scientist would provide information in the form of reference texts, current knowledge, and lab techniques that could be used in the classroom. A scientist could serve as a guest speaker or help arrange for other guest speakers, arrange applicable field trips, and provide guidance for student research projects. A scientist could help arrange for summer internships for teachers and/or students, set up seminars or workshops giving teachers some hands-on experience in the lab. All in all, the scientist would be the catalyst that would make science come alive in the classroom . . . .

> REMEMBER: The idea behind the scientist/science teacher partnership is to transfer science-rich resources from the private sector into the public schools. [Participants] will bring their own ideas and expertise into the partnership. Therefore, we have tried to create a model that gives some basic guidelines, yet remains flexible enough to be molded to meet the individual needs of the parties involved in the partnership.

Partnerships of this type are a feature of collaborative activity at most of the sites we visited, and at many we only heard about. One of the best-established programs of this type is Industry Initiatives for Science and Math Education (IISME), a consortium of San Francisco Bay area corporations and the University of California at Berkeley created in 1985. There is now a large IISME-inspired program in Los Angeles.

Loan Programs

In 1971, IBM initiated a Faculty Loan Program to enable some of its scientific, engineering, and management professionals to serve temporarily in colleges and universities with predominantly minority-student populations, usually by teaching. In 1981, the Program was expanded to include high schools and other educational agencies, and today about four or five IBM employees are involved full-time each year in programs to improve education below the college level. Assignments, in addition to teaching, have included planning activities with schools or other educational agencies, financial consulting, student counseling, and assistance with outreach programs.

While a participant in this loan program, the employee retains his or her status within IBM and is considered to be on a temporary, domestic assignment. Full salary, job-related expenses, and employee benefits continue to be paid by IBM.

Ordinarily, the person serves in the temporary assignment for one year, but extensions are possible and not infrequent. On returning to regular IBM responsibilities, the employee is assigned at or above the level held before undertaking the loan assignment. Since 1981, about 50 IBM employees have served in programs focused on improvement of science education at the high school level.

IBM loans one executive each year to the Southeastern Consortium for Minorities in Engineering (SECME), housed at Georgia Institute of Technology in Atlanta. SECME links more than 25 universities in the southeast with 50 corporations and more than 200 secondary schools to strengthen scientific and technical programs in those schools and help make students aware of careers in engineering. Students are identified as early as the sixth grade by teachers and counselors, then receive special educational attention. About 12,000 SECME students graduated from high school between 1983 and 1987; 85 per cent went on to college. About 50 per cent of the college-attending group entered engineering, science, mathematical, or other technical fields.

Charles Love, of IBM's U.S. Marketing and Services Group in Atlanta, served with SECME during 1987-88, the sixth IBM employee to do so. He provided general assistance to SECME in its relationships with the corporate world. He also took major responsibility for the annual design competition conducted among SECME students in the seven southeastern states. The competition that year invited students to design "mousetrap cars." The objective was to construct the car, with no more than three wheels, that would go farthest on a level surface. Power was to come solely from the spring on the mousetrap. There were additional elements to the competition, including a poster design and an essay.

Love organized the school- and regional-level competitions that would lead to winners presenting their ideas at the special SECME-financed summer program for teachers in 1988 at the University of Virginia.

Love's successor on loan to SECME was Roger Davis of IBM's U.S. Field Marketing Division, where he was Field Measurement Program Manager. To capitalize on Davis' business background, Carolyn C. Chesnutt, SECME's Executive Director since its inception, persuaded Davis to serve as fund-raiser. He designed an overall funding strategy, and elevated to a full-time position an absolutely critical function that Chesnutt herself had been able to do only part time.

Hewlett-Packard makes it possible for some of its professionals to undertake assignments similar to those at IBM. For a year, on a full-time basis, Norman Vlass, Human Resources Manager for H-P's Integrated Circuits Division in Colorado, worked in the Office of the Dean of the College of Natural Sciences at Colorado State University in Fort Collins. Much of his work was related to activities of the Colorado Alliance for Science, a state-wide organization housed at the University of Colorado at Boulder, and one of the oldest, strongest, and largest organizations in the country fostering collaboration among school districts, industry, and higher-education institutions.

Vlass helped to solidify a "visiting scientist" program for the Alliance, very similar to the pairing-of-scientist-with-teacher initiative in San Antonio's Target 90 program. By mid-1988, more than 200 people were involved. He also helped to identify summer positions in industry for teachers, organized "high-tech" seminars for teachers around the state, and helped introduce into Colorado some new chemistry programs that had been designed initially at the Lawrence Hall of Science in Berkeley, California.

Second Career and Early Retirement Programs

Several companies make it possible for certain professional employees to investigate the possibility of a "second career" as they near retirement or early retirement. It is not uncommon, either, for the same opportunity to be extended to younger people in a company when there is a need to cut back on personnel.

In 1986, the National Executive Service Corps (NESC)—primarily an organization that provides management-consulting services by retired executives to non-profit organizations in the fields of education, health, religion, the arts, and social service—launched a special second-career program for scientists and engineers to enable them to become public-school teachers. This pilot program, in cooperation with General Electric in Valley Forge, Pennsylvania and RCA in Cherry Hill, New Jersey, identifies men and women close to retirement in these companies, makes them aware of possible careers in teaching, and, with nearby colleges, enables them to take significant steps toward certification as high-school teachers while still employed at GE and RCA.

Many of the courses necessary for teacher certification are taken during the final year that the person is to be with the firm. While no clear pattern has emerged, companies in the early stages of the NESC's pilot program are moving toward allowing an employee who is preparing for a teaching career to spend about three or four hours a week in schools during the company's work day to observe in classes or engage in other necessary, preparatory work—with no loss of salary.

NESC has also helped the Navy in San Diego and the Army in Fort Bragg, North Carolina to develop similar programs for retiring, technically trained officers. Scores of highly trained naval officers retire annually in the San Diego area, many of them only about 40 years old. Often, they have served one or more tours of duty in San Diego, and wish to retire there. Many of them taught in the Navy.

Lieutenant Commander Kathy Sapp is Assistant Chief of Staff (Administration) for the Naval Base in San Diego. Sapp—with encouragement from her Admiral, assistance from NESC, and support from the San Diego Unified School District—helps those who are near retirement, many of them in their early 40s, become aware of second-career possibilities in teaching. She also works with San Diego State University and other institutions of higher education in the region to help the prospective teachers take major steps toward state certification while they still are on active duty.

In 1987, IBM established a Technical Academic Career Program to assist certain employees make the transition from the company to an academic post. To participate, the employee must be eligible for retirement, must have a scientific or technical background, and must want to embark on an academic career. The individual has the responsibility for finding the new position. Then, a three-way contract is prepared, involving IBM, the individual, and the academic institution.

The person participating in the program formally retires from IBM and begins to receive the retirement annuity. For two years, IBM pays the person 35 per cent of final salary, in addition. The academic institution is required to pay the person at least $15,000 annually during that two-year period. At the end of that time, the 35 per cent supplement stops, and the individual negotiates a new contract with the academic institution. Retirement pay from IBM continues, of course.

Jim Hubbard, 53, was IBM's Area Manager for Intermediate Copiers and Page Printers at their facility in Boulder. Contemplating a career shift from IBM under the Technical Academic Career Program, he started working in 1987 with the Colorado Alliance for Science on a permanent basis, as

Associate Director. As part of his first Alliance responsibilities, and along with general administrative duties, Hubbard strengthened the role of industry in the Alliance by helping to develop and expand its visiting scientist program that brings industry employees to high school classrooms. He also managed the summer fellowship program for teachers.

Why Is the Corporate World Involved?

Many large corporations traditionally have made gifts to educational institutions, but mostly to colleges and universities, and often in cash. A common type of corporate educational philanthropy is to match (or, sometimes, double or triple) an employee's gift to an institution of higher education. There have been special scholarships and endowed professorships, on occasion; some gifts are for special programs or buildings. Often, a company donates equipment, especially since 1986 when the federal tax benefits for such gifts were increased by allowing companies to deduct not only the cost of the equipment but, in addition, half the difference between manufacturer's cost and retail price.

But serious corporate involvement in elementary- and secondary-school improvement has been absent during the last few decades; the improvement of schools has not recently been considered the business of business. Why now?

The general tone and rationale for much of the corporate involvement in education below the college level is reflected (and promoted) in a recent publication of the Committee for Economic Development (CED), a research and policy-oriented non-profit and non-partisan organization. CED's 200 trustees, for the most part, are presidents or board chairmen of corporations, and presidents of universities.

> Human resources determine how the other resources of the nation will be developed and managed. Without a

skilled, adaptable, and knowledgeable work force, neither industry nor government can work efficiently or productively.

The schools are the central public institution for the development of human resources. Tomorrow's work force is in today's classrooms; the skills that these students develop and the attitudes toward work that they acquire will help determine the performance of our business and the course of our society in the twenty-first century.

The case for business involvement not only centers on the benefits business derives from education, but also on what business can contribute. School management and organization can be strengthened through application of modern management techniques, and business guidance in conducting and applying research can have a major impact on this activity in the public schools. Business planning techniques can also help schools prepare better for the future . . . .

A firm and enduring commitment to excellence in education on the part of America's business community is not merely a matter of philanthropy; it is enlightened self-interest. As employers, taxpayers, and responsible community members, business can regard an investment in education as one that will yield a handsome return . . . .

. . . Each firm will have to make its own choice as to the degree of its involvement, depending on local circumstances . . . .

There is little doubt that the influence and power of the business community can be persuasive in arguing the case for increased public financing of the schools. This is an appropriate role for business to play . . . .

> Business at the highest levels must embed in its planning and operations an on-going commitment to excellence in public education. Our schools need a well-informed and involved business leadership all year, every year.[9]

In 1987, four chief executives of major American corporations testified in favor of increased federal appropriations for the education of poor children in America's cities, an unusual and watershed event. At the Congressional hearing, William Woodside, Chairman of the Primerica Corporation (formerly the American Can Company), stated:

> A public education system that provides the full range of educational opportunities for all of its children will strengthen our local communities, provide society with trained workers and informed citizens, help improve our productivity, and halt our slide into a two-tiered society whose have-nots are endlessly shoved into lives without hope or meaning.[10]

The Woodside testimony, with the statement of conviction and call to action by the Committee for Economic Development, finds echoes and endorsement at the local level—with variations and some expansion of the main themes. For example, Hewlett-Packard's Norm Vlass, on loan to Colorado State University and the Colorado Alliance for Science, says, simply, "Rather than throw stones, we're trying to help."

This constructive attitude, and the public statements that accompany it, seemed more the norm than the exception as we talked with corporate participants in cooperative programs to improve science education. Rhetorical tone is important, of course, in determining the receptivity of initiatives from industry by those who are intended as the beneficiaries. If a teacher detects little understanding or respect from people in business who want to improve schools, however well-intended they may be, that teacher is unlikely to enter a cooperative relationship with much enthusiasm.

---

[9] Committee for Economic Development, *Investing in Our Children*, 1985. Available from the Committee, 1700 K Street, NW, Washington, DC 20006. See, also, The CED's *Children in Need: Investment Strategies for the Educationally Disadvantaged*, 1987.

[10] Quoted in Anne C. Lewis, "Washington Report," *Phi Delta Kappan*, April 1988, p. 549.

Finger-pointing and teacher-bashing by corporate leaders are notable by their absence from the late-1980s education-reform scene. Consequently, a recent statement by David T. Kearns, Chairman and Chief Executive Officer of the Xerox Corporation, stands out. Kearns wrote:

> . . . Public education has put this country at a terrible competitive disadvantage. The American workforce is running out of qualified people. If current demographic and economic trends continue, American workers will have to hire a million new workers a year who can't read, write, or count. Teaching them how—and absorbing the lost productivity while they're learning—will cost industry $25 billion a year for as long as it takes . . . Teaching new workers basic skills is doing the schools' product-recall work for them. And frankly, I resent it . . . .
>
> Public education consumes nearly seven per cent of our gross national product. Its expenditures have doubled or tripled in every postwar decade, even when enrollments declined. I can't think of any other single sector of American society that has absorbed more money by serving fewer people with steadily declining service.[11]

---

[11] David T. Kearns, "An Education Recovery Plan for America." *Phi Delta Kappan*, April 1988, pp. 565–570.

Kearns then proceeds to outline his own ideas for reform:

1. More choice ("Today's public education system is a failed monopoly—bureaucratic, rigid, and in unsteady control of dissatisfied, captive markets.");
2. Restructuring ("Schools today ought to look like the smartest high-tech companies look, with lean structures and flat organizations.");
3. Professionalism ("Standards will have to be raised for licensing, hiring, and retention. New standards should emphasize academic knowledge over methodology.");
4. Standards ("All students must be held strictly accountable to the new standards. Just as it is the teacher's job to teach, it is the student's job to learn—no promotions without performance.");
5. Values ("We are producing a generation of young Americans that neither understands nor appreciates our democratic society.");
6. Federal responsibility ("The federal government's role in education is limited and should continue to be so. The one area in which Washington ought to excel—and doesn't—is research.").

Some of Kearns' observations and recommendations are unexceptionable. Others are suggestive. All deserve consideration. None reflect any evidence of prior discussion with teachers or school administrators, the people who must play a major role in any attempts to institute basic changes.

Until just a few years ago, blame-setting statements by corporate leaders, of the sort made by Kearns, were relatively common. Teachers had to shape up and be accountable, they were told—as they absorbed almost the full force of the criticism about decline of American schools. Morale often suffered because teachers, along with school administrators and the institutions that prepared both, tended to be singled out as the villains. They read about themselves in an unfavorable light regularly and over a period of many years. There is little doubt that many able people who left the profession—or chose not to enter it—during that period did so because they felt undervalued, and could make more money and gain greater prestige elsewhere.

Today's absence (or at least muting) of the kind of fault-finding that directs hostile comments toward teachers and school administrators reflects a dramatically different education-reform climate from the one that prevailed through much of the 1970s and well into the 1980s, and seems to us more auspicious. It simply isn't possible to improve schools without the cooperation of those who work there, and they are unlikely to cooperate with people who view them as the main causes of the problems. The impression conveyed by most of the leaders of current efforts to improve the schools is that the problems in America's educational system are problems for everyone, and everyone has a role in making things better.

Don Whitlow, Senior Vice-President for Employee Relations at ALCOA headquarters in Pittsburgh, says, "Education is really a public matter. We all can do something about it, and we [ALCOA] have a piece of that responsibility, too. It's a public relations matter for industry, yes. But we also have a responsibility to help students understand what jobs are like in industry. We also want prospective employees to have the skills necessary to work for us. In [our plants all over the country], we encourage our employees to work with the local schools, as we do at all our plants."

Ron Eich of IBM in Colorado, past Chairman of the Business and Industry Council of the Colorado Alliance for Science and Chairman of the Alliance in 1988–89, writes:

> Why all this interest in science education from industry? Ask the members of the [Business and Industry] Council and you get a stream of answers. Most are parents and are deeply concerned with the quality of their children's education. Many think the successful methods they have learned and developed in industry are directly applicable to school systems. Invariably, reasons like survival in the technological age, the future of our state and nation, untapping the great potential, or remaining competitive with foreign nations will come up.
>
> A strong alliance movement is developing across the nation to bring diverse partners together with the power to achieve important national goals. The rationale for this activity is based on the need to prepare students for the work force, improve the abilities of tomorrow's society, learn to apply knowledge that will evolve from the scientific base, and many more reasons.
>
> And we can be proud of the fact that Colorado has been involved from the start![12]

Corporate Interest in Education–Then and Now

Today's expressions of concern from the business community about the quality of education in elementary and secondary schools, and the determination to do something about it, are not unprecedented. The early decades of this century saw a major attempt to introduce business techniques into the management of public schools. Furthermore, the business community had a critical role in the formulation and enactment of legislation to establish programs of vocational education. Both initiatives enjoyed extraordinary success.

---

12. From "Industry and Education," *Science Interface*, Newsletter of the Colorado Alliance for Science, Vol. 1, No. 2, October 1987.

By the 1920s, with vocal encouragement from the business community, the training of school administrators came to be saturated with techniques that were popular in large companies at the time. "Scientific management" was a watchword, including the regular use of time-and-motion studies.[13] Ellwood P. Cubberley, Dean of Stanford University's School of Education, was one of several figures in the movement to make school administration more "professional," and his speeches and books had a pronounced influence on the education of principals and superintendents everywhere. He insistently and influentially advocated the use of industrial practices in the management of schools, often employing manufacturing imagery to make his points:

> Every manufacturing establishment that turns out a standard product or series of products of any kind maintains a force of efficiency experts to study methods of procedure and to measure and test the output of its works. Such men ultimately bring the manufacturing establishment large returns, by introducing improvements in processes and procedure, and in training the workmen to produce a larger and a better output. Our schools are, in a sense, factories in which the raw products (children) are to be shaped and fashioned into products to meet the various demands of life. The specifications for manufacturing come from the demands of twentieth-century civilization, and it is the business of the school to build its pupils according to the specifications laid down. This demands good tools, specialized machinery, continuous measurement of production to see if it is according to specifications, the elimination of waste in manufacture, and a large variety in the output.[14]

---

[13] Raymond E. Callahan, EDUCATION AND THE CULT OF EFFICIENCY. Chicago: University of Chicago Press, 1962.

[14] Ellwood P. Cubberley, PUBLIC SCHOOL ADMINISTRATION. Boston: Houghton-Miflin, 1916, p. 325. (Quoted in Callahan, p. 97.)

Corporate pressure was one of several forces in the establishment of vocational schools and programs in public schools all over the country. By 1910—with encouragement from the National Association of Manufacturers, the American Federation of Labor, the Grange, the National Education Association, and the Association of American Agricultural Colleges and Experiment Stations—twenty-nine states were providing some form of industrial education. Ten had established technical high schools, and eighteen had established manual-training schools. Eleven states had schools for domestic science, nineteen for agricultural training, and eleven offered industrial and trade courses. Some, like Illinois, authorized the creation of manual-training departments in regular, township high schools.

During World War I, the momentum for industrial training in the public schools continued to build. The Chamber of Commerce joined the growing number of organizations committed to greater efforts in the schools to prepare people for the world of work. Vocational education came to be viewed, increasingly, as one element of national preparedness; President Wilson highlighted the point in his 1916 message to Congress. Finally, in 1917, culminating more than two decades of steadily mounting political pressure, the Congress passed the Smith-Hughes Act, which provided funds for vocational-teacher salaries and for teacher education in trade, industrial, and agricultural (including home economics) subjects. The Act firmly established the place of vocational education in public schools for decades—well into and beyond World War II, in fact. [15]

Today, there is again some talk about schools learning better management procedures from business (as the CED report cited above indicates), though much less now than seventy-five years ago. However, in sharp contrast to corporate motivation three-quarters of a century ago, there is practically no emphasis on vocational education in the statements about education by corporate leaders today, or in the collaborative activity that we observed at local level. A connection is made between education and work, yes. One strong motivating factor by scientists in industry, and by executives, is the need they see to acquaint young people with the demands of employment. But those demands are not identified with the strictly technical skills required in specialized jobs—like welding, carpentry, medical technology, television repair, or food preparation.

---

[15] See Lawrence A. Cremin, THE TRANSFORMATION OF THE SCHOOL (Chapter 2, *Education and Industry*) New York: Alfred A. Knopf, 1961, from which this brief history was drawn.

Instead, skills like reading comprehension and the ability to communicate are emphasized in statements by business leaders. Just as important, corporate managers want to be able to hire people who have character traits associated with high productivity: dependability, honesty, reliability, industriousness, loyalty, adaptability, and efficiency.

In 1983 and 1984, the Committee for Economic Development conducted a survey of employee characteristics needed in industry and reported:

> Specific occupational skills are less crucial for entry-level employment than a generally high level of literacy, responsible attitudes toward work, the ability to communicate well, and the ability to continue to learn . . . .
>
> First, for entry-level positions, employers are looking for young people who demonstrate a set of attitudes, abilities, and behaviors associated with a sense of responsibility, self-discipline, pride, teamwork, and enthusiasm. Second, employers put a strong value on learning ability and problem-solving skills . . . .[16]

---

[16] CED, INVESTING IN OUR CHILDREN, p. 17.

Underlying much of the corporate motivation to improve schools is the conviction that the public school system can play a major role in helping young people develop these characteristics. Some of the collaborative activity at the local level seems, indeed, to contribute toward this goal. The visits to industrial sites, for example, seem to have the effect of demonstrating the kinds of attitudes and skills that are valued in industry. But the business community seems to feel that it has the resources and responsibility to prepare entry-level people for specific, job-related tasks, or that specialized skills can be acquired in trade schools after graduation from high school.

Perhaps, industry is most influential in fostering the kinds of skills and character traits it seems to value most highly in entry-level employees by the very fact of its visibility on today's education-reform scene. When corporate figures become involved personally in trying to improve education, a powerful signal goes to students: Education is considered important by people who count in the community. The underlying message is that it is advisable to study and participate in school-work if one wants a good job. Relatedly, the teacher may be elevated a notch or two in the eyes of students because the work of the local classroom teacher, and the teacher herself, is taken seriously in the business world.

These observations about the skills and attitudes that corporations would like to see in high school graduates focus on the compulsory education of those who are unlikely to attend college. For the others, those who probably will move along to an institution of higher education, the motivating factors in industry go beyond a desire for communication skills and constructive attitudes, as we have seen.

Bob Lyle, of the Southwest Research Institute in San Antonio, wants students to have a clearer idea of what chemistry is all about; he is concerned that not enough academically oriented students choose to major in the field. Charles Love, of IBM in Georgia, wants to motivate more students to enter engineering and other math-based fields. Finally, all the corporate leaders and scientists we met, without exception, have a strong commitment to do all they can to increase the number of women and minority-group members who enter scientifically based professional fields.

Corporate Citizenship

Hewlett-Packard is one of the largest corporate employers in the State of Colorado. As such, its executives and other professionals want the company not only to turn a profit but to be well-regarded in the community, to be seen as contributing to the general welfare of Colorado. Five community-oriented committees operate for the company on a state-wide level, one focused on "quality of life" that emphasizes environmental and other health-related issues. The other four concentrate on education, including one focusing on kindergarten through grade twelve.

The Colorado effort comports easily with national and international objectives for the company. In a 1986 "Statement of Corporate Objectives," Hewlett-Packard lists "Citizenship" as one of seven company responsibilities:

> OBJECTIVE: To honor our obligations to society by being an economic, intellectual and social asset to each nation and each community in which we operate.
>
> All of us should strive to improve the environment in which we live. As a corporation operating in many different communities throughout the world, we must make sure that each of these communities is better for our presence . . . .
>
> Each community has its particular set of social problems. Our company must help to solve these problems.

> As a major step in this direction, we must strive to provide worthwhile employment opportunities for people of widely different backgrounds . . . .
>
> The betterment of our society is not a job to be left to a few; it is a responsibility to be shared by all. [17]

Similar sentiments were voiced to us repeatedly as we talked with corporate leaders in Philadelphia, Atlanta, Cleveland, Denver, San Antonio, and Los Angeles. Dan Mitchell, of the Southwest Research Institute, stressed the fact that the Institute is a large employer that wants to contribute to as well as gain from San Antonio. Independently and forcefully, these executives spoke about the importance of community, about the need to rebuild run-down cities, about the importance of Americans' rediscovering their obligations to one another.

To us, it seems that many leaders in the corporate world are trying, through their school-directed initiatives, to help re-identify and re-establish whatever it is that binds American society together. This search for community is inclusive, and every effort seems to be taken to bring in those historically at the margins: the poor and, especially, racial minorities. It seemed to us that there is a genuine altruism beneath some of the corporate programs to improve education at elementary and secondary school levels—though it is more commonly and forcefully couched in terms of enlightened self-interest.

One footnote, however: The corporate involvement in education that we saw—and that seems to be growing—characterizes large and, for the most part, older companies. William Parshall, of the Hunt Manufacturing Company in Philadelphia, points out that, "The 20 to 30 large companies in the city carry almost all the weight of community-based activities. Despite the fact that [Philadelphia] is America's fourth-largest city, its corporate base is relatively small, compared to Pittsburgh, for example. New companies haven't developed a sense of corporate responsibility yet. Maybe it's a 'generational matter.'"

---

[17] Hewlett-Packard STATEMENT OF CORPORATE OBJECTIVES. Hewlett-Packard Corporate Headquarters, 3000 Hanover Street, Palo Alto, CA 94304.

Private Money and Public Schools

We cannot conclude a chapter on the role of private interests in public education without pointing out a possibly puzzling anomaly. The central issues in President Reagan's education agenda, beyond his determination to abolish the federal Department of Education, were (1) reintroduction of school prayer to public education, (2) tuition tax credits for those who send their children to non-public schools, and (3) the introduction of voucher plans that would enable a parent to use public funds for the direct financing of private education. Despite the vehemence and the persistence with which a very-popular president pressed these recommendations (and, personally, very little else in education), they received only passing attention from the public, scant interest from elected politicians, and practically no notice from those who speak for corporate America.

There is talk of the importance of greater educational "choice" on the part of many corporate executives and politicians, but almost always within the framework of a strong system of *public* education. For us, this fact adds credibility to the vigorous statements about the importance of community and corporate community-service that one hears from many of America's business leaders. Public schools are the common schools; they serve children of all the people.

There may well be a cultural memory in this country that recalls the role of public schools in the past in forging a sense of nationhood among a people who came from all over, speaking many languages. When one looks today for unifying institutions in the society that seem to emphasize the values the country would like to be known by, there seem to be few. It's not the church. Less than in past is it the traditional family, with two parents and several children. It's not government.

What do Americans share, besides sports and network television? It does seem to be the public school: that is, the *common* school, invented in nineteenth century America, chiefly to perform the functions that the country may be expecting this institution to perform once again: to reflect common purpose and provide common experiences. An historical sense of this mission for public education may propel some corporate leaders, whether they emphasize it or not, or even whether they are aware of it. It is difficult, otherwise, to explain the intensity of commitment we saw, or the sometimes impressive shift of corporate resources.

· 3 ·

UNIVERSITIES

Of 43,000 engineers graduated from American universities in 1971, 407 were Black. At the 1972 Engineering Education Conference, J. Stanford Smith, then Senior Vice-President of General Electric and shortly to become Chief Executive Officer at the International Paper Company, asserted, "It takes about fifteen to twenty-five years to rise to top leadership positions in industry. So if industry is getting one per cent minority engineers in 1972, that means that in 1990, that's about the proportion that will emerge from the competition to the top leadership position in industry. This is a formula for tragedy . . . [Without change] industry will not be able to achieve its goals of equality, and the nation is going to face social problems of unmanageable dimensions." [18]

Some industrial firms offered scholarships to increase the numbers of Black and other minority students. Loan and work-study programs were instituted at many universities. Colleges made special attempts to reach Black high school students. But there was little change in the overall picture; few Black students were interested and qualified. Part of the difficulty stems from the fact that it is already too late at age 17 or 18 to decide to pursue a scientific or technical career. To be admitted to a college program in science or engineering, it is necessary to have become sufficiently motivated early in the high-school years to take the necessary prerequisites, especially in mathematics.

---

18. Quoted in: Southeastern Consortium for Minorities in Education, *1985–1986 Annual Report, Celebrating a Decade of Enrichment*, p. 5.

About 35 per cent of Black secondary-school students live in the Southeast. In 1975, the deans of six engineering schools in the region formed an organization to change things, the Southeastern Consortium for Minorities in Engineering (SECME). SECME was to focus on identifying and assisting Black and other minority students, beginning in grades seven, eight, and nine. The Sloan Foundation supported the early efforts with a grant of $250,000 for 1977, growing to $1.1 million over a four-and-a-half year period.

Gradually, additional funds were secured from industry, from other foundations, and from the federal government (the National Science Foundation). Today, about twenty-five colleges and universities in the Southeast are members of SECME. Summer institutes for teachers and school administrators are conducted. Instructional materials are produced that provide mathematics, science, and English teachers with engineering-oriented content. Most importantly, SECME activities are well-publicized in the region. Awards and other forms of recognition flow to successful students. Parents and students pay more attention to engineering as a career possibility.

Today, about 80 per cent of SECME students go on to college. Approximately half of that group majors in engineering. In the school year that ended in the summer of 1984, 2,200 SECME students graduated from college.

William M. Sangster has been Dean of the College of Engineering at the Georgia Institute of Technology in Atlanta since 1974. Georgia Tech was one of the six initiating universities for SECME, and its headquarters are located there in space donated by the university. Sangster says that the rural south offers a rich source of Black students. Furthermore, he detects a higher level of ambition and a greater willingness to work on the part of Blacks in the rural south, as compared with those in the urban north. Engineering schools can attract many of these Blacks if high-school programs are strengthened so that graduates are qualified.

As an example of SECME success, Sangster points to the city of Macon. When Sidney Lanier High School became Macon Central, after racial integration, it virtually disappeared as a source of students for Georgia Tech. Prior to integration it had been one of the major "feeder" high schools in the State for the University. Georgia Tech and SECME undertook a major initiative to inform the students about the high school work necessary to enter Georgia Tech. The students, in turn, exerted pressure on their parents and on the high school to insure that the necessary courses were offered. Today, Macon Central is again a significant provider of students to Georgia Tech.

Getting Universities to Work with Schools

William Sangster's motivation in using Georgia Tech's resources to improve secondary education mirrors not only the views of administrators in other SECME institutions, but also those of presidents, deans, and professors at universities around the country. For more than a hundred years, university faculty have complained about the preparation of high school graduates for college-level work. In fact, the major reason for establishing departments or schools of education at many public and private universities in the early years of this century was to offer a base from which the university could try to improve the academic preparation of those who enter these universities. At most land-grant universities, high schools were established, as part of the school of education, to serve as preparatory schools. (Many were discontinued in the 1960s and 1970s under the pressure of budget cuts and accusations of elitism; many still exist, though their missions are now more varied.)

Though college-level interest in the improvement of high-school education has a long history, key demographic elements of American education have changed—and the focus of concern has shifted accordingly. Before World War II, a secondary school education was completed primarily by students who intended to go to college. In 1939, about 25 per cent of the population then in their thirties had attended high school for four years. By 1979, that figure had jumped to about 75 per cent for Blacks and 85 per cent for Whites.[19] (By 1985, however, the overall figure dropped to about 73 per cent.[20])

Americans, though, tend not to focus on how full the high-school class is, but on how empty. If 75 per cent of young people attend high school for four years, that means, of course, that about 25 per cent drop out. That figure is socially and politically unacceptable today, particularly in view of the fact that the dropouts are predominantly poor, Black, or Hispanic. There is a relatively new consensus that the country must try to make high schools the institutions from which all who are mentally competent indeed do graduate—and many of whom go on to college.

University concerns about secondary education go beyond their need for qualified students, however. Universities, particularly those supported primarily by the state, need a broad climate of public support. Eugene Cota-Robles, a biologist, is Assistant Vice-President for Academic Affairs for the nine-campus University of California system. He says, "In California, and eventually the entire country, we are experiencing a change in demography that can, if not acknowledged, lead to some serious consequences." He continues:

> The present population of California is about 25 per cent Mexican-American, 10 per cent Black, 12 to 15 per cent

---

[19] National Center for Education Statistics, *The Condition of Education.* Washington, DC: U.S. Department of Health, Education, and Welfare, 1979.

[20] Harold L. Hodgkinson, *All One System: Demographics of Education—Kindergarten Through Graduate School.* Washington: Institute for Educational Leadership, 1985.

> Asian, and the rest White. . . By 2020, the State population might be something like 35 per cent White, 35 per cent Hispanic, 10 per cent Black, and 20 per cent Asian.
>
> A population of 35 per cent Hispanic presents a problem in the following way: To date, these people have been participating very little in higher education. In California right now, 28 per cent of the Whites hold a bachelor's degree [among those over the age of 25], along with 35 per cent of the Asians, 15 per cent of the Blacks, and 6 per cent of the Mexican-Americans. If you have a group that large . . . , you are going to be surrounded by a significant group of taxpayers who are not participating. This is going to present political problems for the University because it relies on the good will of the people of the State. I think the University needs to help improve the schools these people are educated in.

These dramatic and significant shifts in school-attendance patterns are but one more impetus for new and concerted attention by college instructors and administrators to the quality of secondary education. There are others. During the 1960s and into the 1970s, the country was opening a community college every *week*, on the average, as a result both of the surge in births from 1946 to 1962 and the increasing rates at which young people were going to college.[21] However, the number of Americans of college age in the year 2000 will be smaller than in 1980. Many universities are beginning to worry about sustaining their enrollments and making full use of the physical facilities that were built during the decades of rapid population growth. Closed and rented elementary and secondary schools in virtually every community—accompanied by a reduced force of teachers at these levels—provide vivid and proximate examples of what could happen to colleges and universities.

---

[21] By 1980, about half of high school graduates were pursuing some form of higher education. Today, about one worker in four has a college degree.

Public Service

While some of the attempts by universities to improve the quality of secondary education seem to stem from a desire by university presidents and other top-level administrators to do what they can to secure a dependable flow of both resources and capable students, there are also some education-related considerations.

There has been considerable comment in recent years about the "materialism" of today's college-age youth. Increasing percentages of freshmen state that they go to college primarily to improve their money-earning potential. Pre-law and business programs are growing in enrollment, often at the expense of studies in the liberal arts and sciences. The resulting change in campus ethos has sufficiently disturbed some professors and administrators that they have gone beyond quiet hand-wringing to using their positions and platforms to highlight the importance of public service and volunteerism. Frequently, their pleas stress the necessity, for the sake of the nation, of university-level student and faculty involvement in programs to improve the quality of the schools.

For example, in the early 1980s, Stanford President Donald Kennedy started to inject statements about the importance of public service careers for college graduates in his commencement addresses. In 1984, Stanford followed up by establishing a Public Service Center to focus some of Stanford's activities in this sphere. The Center helps undergraduates explore employment possibilities in government and teaching—sometimes as volunteers and sometimes in special internships, often for academic credit.

A sizable effort in the Center (and in similar activities elsewhere) is a tutoring program for poor and minority students in nearby schools. In the process, students have an opportunity to judge their possible interest in a career commitment to elementary or secondary-school teaching. Recently, the Center established a program that makes it possible for a limited number of non-academic employees to volunteer to work with local schools for up to four hours a week. This staff-time release program is coordinated in the nearby schools with similar programs sponsored by other employers in the community.

Academic Alliances

Scores of universities in the last few years have developed new relationships with nearby school districts. The arrangements take many forms—from the relatively modest and informal provision of tutoring services by undergraduates, to officially established inter-institutional agreements aimed at establishing cooperative activities on a sustaining basis. A large number of the new programs focus primarily on in-service education of teachers in the surrounding community. A few try to move toward this goal by building on the existing teacher-preparation program; for example, there are special opportunities for school-district teachers who supervise the university's student teachers to enroll in courses on campus. In several of the university/schools programs, curriculum issues are examined jointly by professors and high-school teachers. A few universities try to establish collaborative research and/or development programs with nearby (and, occasionally, distant) schools.

The movement toward formalized partnerships between universities and schools has now acquired sufficient momentum for one of the country's major school-reform figures, John Goodlad at the University of Washington, to have established the National Network of School-University

Partnerships for Educational Renewal.[22]

One popular and significant type of venture that draws universities closer to pre-collegiate education is a program in which a university commits itself to the development of specially tailored courses in science (or the humanities, or the social sciences, or the arts) for teachers in nearby schools—often, in the process, involving faculty who have not previously worked very much with teachers. (There is a trend toward labeling such programs "alliances," but "partnership" is often used, as are other terms, like teacher "institute"; consistent terminology has not yet emerged in the world of collaboration between schools districts and other agencies.) In the most successful programs of this type, teachers have a significant role in planning the courses, frequently by pointing out their specific subject-matter needs. The university then tries to identify appropriate faculty from the relevant departments to work with the teachers.

One of the first and most successful partnerships operating in this general mode is the Yale-New Haven Teachers Institute, created in 1978 and directed since its inception by James R. Vivian. Participating teachers, about 80 each year, are designated as "fellows." They agree to attend talks and seminars that are conducted by regular Yale faculty. A central part of each fellow's responsibility is to develop a curriculum unit related to the work in the seminar. The unit is then publicized and made available to other teachers.

For example, Charles A. Walker, Professor Emeritus of Chemical Engineering, offered a seminar in 1987 titled, "Science, Technology, and Society." Nine teachers enrolled for a series of thirteen meetings to consider some of the interrelationships between human needs (food, shelter, health, etc.)

---

[22] Kenneth A. Sirotnik and John I. Goodlad (editors), SCHOOL-UNIVERSITY PARTNERSHIPS IN ACTION: Concepts, Cases, and Concerns. New York: Teachers College Press, 1988, Chapter 1.

and human values (respect, wealth, power, affection, etc.). Individual sessions centered on topics like warfare, the environment, technology assessment, and a case study of the cleanup of a river.

Each fellow developed a curriculum unit that was related to the seminar. The fellows used Walker as a consultant in developing the units, each fellow meeting at least twice with him, first to decide on the dimensions of the task and then for assistance in compiling the material. Technical and editorial assistance are also provided for the fellows.

One of the units, by a teacher of home economics, was a cross-cultural study of clothing manufactured with natural and synthetic fibers. Other participants focused on space exploration, teen pregnancy, and the environmental impact of chemical waste disposal. These units, when completed, were added to the hundreds produced since the Institute was established, indexed by grade-level and topic, and made available to teachers throughout New Haven.

The participants in Walker's seminar stressed the intellectual stimulation of their Yale-based activities, both as a result of the materials and insight provided by Walker, but also because of the stimulation they receive from one another. Classroom teachers do not get to talk much with adults in the course of their work; the seminar participants began to develop collegial relationships that seemed enriching enough to emphasize the point strongly and repeatedly in a conversation with us. Several of the participants commented on the Institute's influence in softening town/gown relationships.

For Walker, the seminar provided an opportunity for him to explore new ideas. He was becoming interested anew in science, technology, and society relationships and viewed the seminar as a chance to consider a new line of research and study.

For 1988 and 1989, science seminars were being considered on hormones, epidemiology, navigation, astronomy, fetal development, meteorological storms, aerodynamics, crystals, and superconductivity. Vivian took primary responsibility for making the matches between Yale faculty and the needs expressed by the teachers.

The Institute is guided, on the schools side, by a team of coordinators drawn from New Haven. The coordinators help Vivian with both planning the seminars and general evaluation of the program. Their meetings are characterized by verve and commitment. At a teacher-coordinators' meeting in 1987, one teacher said, "I would no longer be teaching in New Haven if not for the Institute." Another quickly seconded the sentiment. Jane Marshall, an English teacher, said, "I would have burned out if not for the stimulation of contact with Yale." Several made the point that their students view them differently because they are studying at Yale. "Our students see us as students also. The Institute demonstrates that education is a continuum," said Marshall.

Vivian points out that one of the motivating elements for some of the Yale faculty is that they enjoy working with people of greater maturity than Yale undergraduates (or even graduate students). Most of the Yale faculty involved in the Institute come not only to appreciate more the work of high school teachers, they also become acquainted with and admiring of some of the difficult-to-acquire abilities that characterize effective teaching.

Charles H. Long, Yale's Deputy Provost, says, "I would like to get some of the New Haven teachers involved in instruction at Yale. For example, they could provide some of the basic language instruction that is now in the hands of graduate students. Yale could pay for it." (Long himself has a record of strong interest in secondary education. For many years, he helped read Advanced Placement examinations in English.)

The Yale-New Haven Teachers Institute operates on an annual budget of about $500,000, including approximately 45 per cent of the budget in the New Haven schools for staff development. The remainder comes from national foundations, a local one, and Yale itself. This sum supports about 80 fellows in five seminars in the humanities each year and three in science.

Partnership Pairs at Universities

Some of the university-based programs with the schools are similar to those that have been established with industry. Joan Ratner is a microbiologist at the University of Texas Health Center at San Antonio. She had been involved in judging exhibits at local science fairs. "However," said she, "some of the projects really would have been good, but some students had erroneous ideas."

Partly as a result of that experience, she and her colleague, Joel Baseman, who chairs the Microbiology Department, decided to teach a summer program for area teachers. "It's unfair to expect teachers to keep up with developments in microbiology," said Baseman. So, with assistance from Target 90's Science Collaborative and Dave Sugg, teachers were identified and Health Center facilities were used for a special summer program.

Nancy Klepper, a high school biology teacher, was one of the participants. One of Klepper's students, Miriam Horowitz, had participated in a science fair the preceding year and was still upset about what she considered an unreasonable action by the judges. Miriam's science fair project had centered on the storage of riboflavin in food. In 1986, her experiments showed that riboflavin was degraded by light, as measured by a reduction of fluorescence. One of the judges, however, stated that although the riboflavin might not fluoresce, it still might be riboflavin, and nutritionally valuable.

"Miriam's drive to prove the judge incorrect was intense," reports Ratner. Several months after the teacher institute, using the lead provided by Nancy Klepper, Miriam, who was determined to pursue the matter for the 1987 science fair, phoned Ratner for help. Miriam had learned that a certain bacterium requires riboflavin to live and grow, and therefore could be used in an assay, but she had never before worked with bacteria. Ratner taught Miriam how to reconstitute a culture (that had been secured from the American Type Culture Collection, since the Health Center did not stock the organism), stab deep agar culture tubes, and streak plates. Miriam's experiments revealed that while riboflavin supported the bacterial growth, and was therefore nutritionally valuable, the photo-degraded products, lumiflavin and lumichrome, did not. The work was original.

For this project, Miriam won some awards: the Alamo Regional Science and Engineering Fair, Third in Category Biochemistry; the Texas Junior Academy of Science (San Antonio), Highest in Category Biochemistry; the Texas Junior Academy of Science (State), Second Runner-up Overall.

MESA

Mathematics, Engineering, and Science Achievement (MESA) is a program with many of the same goals as SECME, but one that precedes SECME by several years. It was conceived in 1968 by Wilbur Somerton, an engineering professor at of the University of California, Berkeley, and launched in 1970 with a pilot program at nearby Oakland Technical High School. Industry had been unsuccessful in recruiting Black and Mexican-American engineering graduates in the numbers they wanted, primarily because not enough minority-group students had taken the necessary preparatory subjects in high school, particularly mathematics. MESA was to focus on academic counseling for minority-group youngsters and accompanying support services.

In 1977, with help from University of California administrators, the Lawrence Hall of Science in Berkeley, and the State Department of Education, MESA went state-wide. Today, it has pre-college centers at several campuses of the California State University system (Bakersfield, Fresno, Fullerton, Long Beach, Los Angeles, Northridge, Sacramento, San Diego, San Francisco, San Jose, and Sonoma). Centers are located, also, at the Berkeley and Santa Barbara campuses of the University of California, and at Harvey Mudd College, Los Angeles Southwest College, Stanford, and the University of Southern California.

MESA, since 1979, has been written into the State of California budget, originally at $250,000 and now at a figure approaching $2 million annually. These funds are administered through the University of California system. There is also an allocation through the California State University System of $250,000 for MESA activities. Corporate contributions in 1988 totaled $563,000, exclusive of "in-kind" services that often take the form of executives on loan. MESA also receives philanthropic-foundation grants, which in 1988 totaled $1.6 million. A small grant of $5000 from the van Loben Sels Foundation helped MESA get started. In 1984, it received $603,000 from Carnegie Corporation to help launch programs below the high school level. MESA headquarters are at the Lawrence Hall of Science in Berkeley, an organization with a strong reputation for its outreach programs in science and mathematics.

At MESA's inception, it worked with students beginning in tenth grade. Now it starts in junior high school and middle school with the Junior MESA Program. Precollege centers at more than thirty higher education institutions serve about 175 high schools in the State of California and about fifty junior high and middle schools. The programs include tutoring for MESA students, field trips to local businesses and universities, preparatory classes for college-entrance examinations, career-related speakers, summer programs and intensive counseling. Harold Bannerman of the Berkeley-campus MESA program says that the junior high school part of MESA's work has proved to be the most important because of the need to identify students at as young an age as possible.

Before acceptance in the Berkeley Junior MESA Program (for middle- and junior-high-school students), prospective participants are told:

> Be committed to working as hard as you can in *all* subjects.
>
> Enroll in *both* a math and a science class every semester.
>
> Maintain a grade point average of at least 2.5 in all academic subjects.
>
> Attend weekly business meetings.
>
> Attend *all* academic/tutoring sessions.
>
> Be willing to help fellow members.
>
> Attend quarterly grade review counseling sessions.
>
> Be on the lookout for potential Jr. MESA recruits.
>
> Participate in extra-curricular Jr. MESA activities.
>
> Encourage your parents to lend their support! [23]

In 1986–87, MESA's Precollege Program served more than 4,000 students in grades seven through twelve, with about one-third of the group in grades seven through nine. Fifty-eight per cent were Mexican-American, 37 per cent Black, and 5 per cent American Indian or Puerto Rican. Hispanic students in MESA have increased in recent years, but not at the same rate as the State's school population. About

---

[23] From a letter to students and parents from Harold Bannerman, Assistant Director, MESA Program, College of Engineering, University of California, Berkeley, 22 September 1986.

85 per cent of MESA seniors go on to four-year colleges, where more than 80 per cent major in math-based fields.

In looking back on MESA's development since the 1960s, Fred Easter, the Statewide Director since 1986, says that, with expansion, it has been necessary to decentralize some of the functions. Four regional offices are being established, and special pains are taken to involve center directors in statewide decisions. In 1986–87, it was felt necessary to "defund" one university-based center, partly because there wasn't sufficient study space for the students. The question of appropriate standards, and their enforcement, does not arise often, however.

MESA is mature enough and successful enough to serve as a model for one type of school-university connection, and it has been copied widely, with spin-offs now in Arizona, New Mexico, Colorado, Washington, Oregon, Michigan, Maryland, Texas, Connecticut, and North Carolina, plus a combined effort in Missouri, Kansas, and Nebraska.

North Carolina's version is called the Mathematics Science Education Network (MSEN). It was launched in 1984 by Chancellor Fordham of the University of North Carolina at Chapel Hill, who points out that the University, created in 1789, predates the public schools and has taken a serious interest in pre-collegiate education for decades.

MSEN is directed by Vinetta Jones, who had worked in the California program. It is now decentralized to nine University of North Carolina campuses, with the coordinating unit at Chapel Hill and a research and development center at North Carolina State University. Each center has a full-time director and operates twelve months a year. The aim is to reach children beginning in grade six. Four thousand teachers participated in 1987–88.

The program touches the lives of children and adults in personal ways. Listen to some principals:

Now we have an advocate for minority children.

Students are more confident and assertive.

Test scores have increased substantially; the children have developed great attitudes toward science. [They have] higher aspirations.

There have been some tremendous changes: an increased sense of pride; peer pressure is not as bothersome; there is an increased desire to go to college. This the finest program of its type I have seen.

Parental involvement is critical. With this program, it has been positive.

Some teacher comments:

Students show improved confidence through a common goal, program, and support structure.

There have been positive effects on grades.

By January, even the most withdrawn children raised their hands to participate.

Students who, at the beginning, spoke in short sentences or failed to elaborate a point began to perform or engage in discussions spontaneously.

The program has given its teachers a new status.

The program validates our claim that we are committed to all of the children.

The program has created in me a sense of caring and sensitivity to minority issues due to my experience as a White participant among predominantly Black groups.

Parents:

My son is eager to participate.

Program teachers took a lot of interest in my child, and she now takes greater interest in school.

Before the program, my daughter did not receive attention while she was failing in algebra.

[My son] is eager to explain homework to his younger brother.

My daughter now wishes to be a doctor rather than a nurse.

And some children:

MSEN taught me how to try, how to set my goals . . . I am motivated and am proud of having overcome the shame of being a 16-year-old eighth grader.

It has taught me to like school.

I am more interested in the future now. I wanted to drop out of high school, but now I wish to go to MIT and study architecture . . . .

I wasn't interested in college, but I am now. I wanted to be a nurse (my mother is a nurse) or a secretary, but now I prefer to be a veterinarian, if I could be anything I wanted.

The program created self-esteem for me, resulting in a second-place finish in a math contest in Raleigh.

A Consortium in California

Unlike North Carolina's MSEN, most of the university-based collaborative efforts we visited were centered in a single institution of higher education. If more than one college or university was involved with a school district (as was often the case in the large cities we visited), there was little attempt by the higher education institutions themselves to coordinate their activities. Rather, the school district or a third-party served to direct the professorial traffic.

An ambitious program to coordinate the work of several post-secondary institutions in essentially a single collaborative activity is centered in southern California. The Student/Teacher Educational Partnership (STEP) brings the University of California at Irvine, Rancho Santiago Community College, Chapman College (a private, four-year institution), and the California State University at Fullerton into a collaborative arrangement with the Santa Ana Unified School District (SAUSD).

University of California faculty, for example, are involved with Santa Ana teachers in curriculum revision, attempting to integrate science and math in the new State curriculum framework; they are also offering workshops for teachers in math, physics, and biology. An integral and distinguishing feature of STEP is a peer-tutoring program in math and science, wherein secondary school students provided personalized instruction at special Cooperative Learning Laboratories. Rancho Santiago Community College trains all the tutors. Chapman College takes responsibility for a program to help teacher aides in Santa Ana qualify for credentials as teachers. Fullerton has used the STEP vehicle for training Santa Ana counselors about the shift in admissions standards for the California State University system and also for a program to involve parents in the education of their own children.

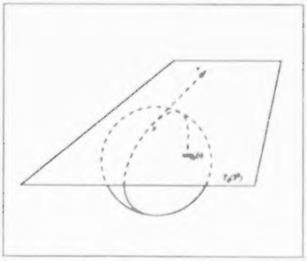
STEP is governed by an Administrative Council composed of people delegated by the head of each of the cooperating institutions, with administrative functions located at UC Irvine. The Council is a forum for the various institutions to shape the overall STEP program, matching the strengths and priorities of each particular college or university to Santa Ana's considerable needs. According to Manuel Gomez, Assistant Vice-Chancellor at the Irvine Campus and a major figure in the program, the Council is an essential feature in assuring the necessary level of coordination. Each institution has a visible and formal stake, and participates in the decisions that are made.

Jack Peltason, the Chancellor at the University of California at Irvine, echoes the comments of many leaders of the higher education community in describing his motivation for supporting STEP. "[In view of current demographics], I can't imagine a more important issue at a public California university than getting more minority students. We must deliver the university to the next century—and make sure it's still a university."

The Santa Ana Unified School District serves more than 37,000 students. 27,400 are Hispanic. 32,200 are minority. Furthermore, the district is growing at the rate of about 1,000 students per year. This growth, along with resignations and retirements, means that the district must hire about 230 new teachers annually.

The school district is making considerable progress in many areas. For example, student performance on state-mandated standardized tests have improved more in Santa Ana than in any other district in the state. Twenty-six of its schools have a connection with local industry: Western Medical, Digital, Apple, Fluor, and others. A new school, Century High School has specialized curriculum strands in medical biology and computer electronics.

Edward Krass, SAUSD's superintendent, and his staff are impressed with STEP's influence on the students and teachers. He values the contacts at Irvine for his younger teachers especially; he's lost many of them to industry and views the Irvine connection as one way to keep them involved in education. For the students, the tutoring program and the links to the colleges and universities gives them role models. "It used to be 'we' and 'them' [with colleges and universities]. Now we're on a first-name basis. I've seen lots of programs come and go. STEP is working."



· 4 ·

MUSEUMS

Science museums have traditionally performed their educational functions by providing places for people to become familiar with objects from the natural world and the products of remote civilizations. By the third decade of this century, imposing edifices had been constructed in many of America's cities in which a large variety of plants and animals were preserved, stuffed, and exhibited—along with geological specimens and artifacts from unfamiliar civilizations, both ancient and contemporary. These places, sometimes called museums of natural history, were primarily buildings for a public newly interested in popular science to become acquainted with exotic objects and peoples.

Gradually, these museums of science established a cautious, tentative, and modest set of relationships with nearby schools. Hesitantly, like art museums, they became places where, on occasion, classes could come to learn something interesting and edifying that could not be studied as effectively in the classroom. And, as in art museums, the visitor to such places usually was expected to be quiet; look, but not touch; and come away with a new level of appreciation for the objects that had been preserved or constructed, and what they represented. The atmosphere was more like a library than a laboratory.

In the last two decades, however, most science museums have undergone a radical transformation in their approach to the public, including a new set of relationships to the schools. Their role has shifted from an emphasis on preservation and display to one that fosters more-active involvement by the visitor in learning about the ideas that are featured in the exhibits, the displays now are often designed as invitations to inquiry.

As an indicator and symbol of the nature of the change, these institutions have tried to discourage the public from thinking of them as museums in the conventional sense, but rather as science "centers"—implying that they are places for active engagement by those who visit. The Washington-based national association of these institutions, for example, calls itself the Association of Science-Technology Centers.

Some of the first science museums to encourage a more active role for the visitor were Chicago's Museum of Science and Industry and Philadelphia's Franklin Institute. Those who came to these institutions pushed buttons to initiate motion in some of the displays, or to highlight different features of the exhibits. They tried new technologies, like push-button telephones and labor-saving kitchen devices. They positioned themselves in front of parabolic reflectors to demonstrate how their whispered utterances could be heard fifty yards away by someone standing near a similar reflector aimed at the first.

However, it was San Francisco's Exploratorium, in particular, that led the way in demonstrating the potential of this new direction—providing a model for many other institutions to study and, possibly, emulate. At the Exploratorium, created in 1969, there is a deliberate attempt to de-emphasize the polished and perhaps forbidding dimensions of exhibitry, in favor of designs that draw the visitor into active involvement with whatever is going on. The place looks and sounds like a busy workshop, where even the unit that constructs new displays is out on the main floor for all to see. There is virtually no attention at the Exploratorium to the traditional preservation function of science museums.

Frank Oppenheimer was the pioneering Director of the Exploratorium and founder of ASTC. He has said, "Although all museums are based on props, most museums, especially science centers, are basically museums of ideas. What we communicate in science centers are ways of thinking about nature and technology." [24]

Camping In

Once a year, the Franklin Institute in Philadelphia opens its doors on a Friday evening, after the building is closed to the public, to admit about 600 teachers and school administrators who spread throughout the building and spend the entire night learning about science, with the help of museum staff and guest lecturers. The Teacher Overnight Science Program at the Institute is patterned on similar programs for children that many science centers have been running for years (frequently as a way for scouts to earn a merit badge).

Franklin Institute's program for teachers enables participants to explore among the exhibits, view the night sky, and generally share impressions and teaching ideas. They take the place over, often bringing sleeping bags, cots, and suitcases. Roree Iris-Williams, the Director of Educational Services at the Institute, says, "Many [teachers] have memories of the museum from when they were children, and this gives them the chance to experience the museum as a kid again. Most teachers who visit in the daytime bring a class with them. They have to focus on the students and don't get a chance to interact with the exhibits themselves." [25]

At the 1987 Overnight, teachers learned to make paper, used stethoscopes, measured the magnitude of stars, ate a catered dinner, saw a laser show in the planetarium, participated in special workshops conducted by NASA and the Philadelphia Zoo, and tested miniature parachutes using the Institute's main stairwell. Some teachers led their own workshops. "It was very different from a college class. Here you see teachers teaching teachers and teachers learning from teachers," one said.

---

[24] From a speech to the American Association of Museums, reported in *Museum News*, November–December 1982, p. 39.

[25] See Iris Roree-Williams and Pam Inglesby, "Tired but Inspired . . .," *Science Scope*, forthcoming.

Showing a Different Face of Science

The New York Hall of Science is a relatively new institution housed in a facility left over from the 1964–65 World's Fair. It represented a major political victory to establish the museum in the first place because the site in the Borough of Queens was thought to be relatively inaccessible. Since its establishment, the Hall of Science staff has made special attempts to serve New York's varied minority population. "Queens has become the entry-point for immigrants to the City," says Education Director Peggy Cole, "and we have a special responsibility to reach them. People who come to us are just down-home folks, like people who go to the zoo. Not like the art museum group."

Not only is the New York Hall of Science housed in a left-over building, most of its exhibits also are hand-me-downs. IBM, seeking a special exhibit for its new building in an upscale part of Manhattan, had re-packaged and redesigned some Exploratorium displays on light and the eye to give them a more sleek and "professional" look. When the time came to end the exhibit, the New York Hall of Science negotiated with IBM to have the display moved to the Hall's Queens site. "Serendipity is everything," says Cole. (The administration of the Hall, however, had to agree to keep the exhibits faithful to IBM design standards, inasmuch as IBM is identified as the donor.)

Most museums make extensive use of people who are not full-time employees to explain exhibits to visitors. Many of them depend on unpaid docents. Cole, however, does not like to rely on volunteers. Instead, the New York Hall of Science trains undergraduates from nearby colleges to serve as "explainers." These young people orient school groups, teach workshops, and interpret exhibits. Currently, there are about 40 explainers, half of them women, and almost all of them from minority groups. They work at the Hall of Science for up to 20 hours a week. Thus, says Cole, "The face of the museum is young and minority. We hope minority children who visit the Hall will have good examples of people who go into science."

Cole chooses explainers, in part, for their maturity and their ability to work with other people. Their photographs adorn a prominent wall near one of the museum entrances, reinforcing the picture the museum wants to portray of itself to the community. Some of the explainers, on the basis of their experiences at the museum, decide to become science teachers. Cole spends significant portions of time counseling the explainers. "Many undergraduates think of themselves as either brain surgeons or lab technicians. They need a more-realistic picture of themselves."

Other museums, too, have explainer programs. At the Exploratorium, there are no guards or uniformed attendants. Instead, explainers—paid high-school students in this instance—circulate among the visitors on the floor of the museum. A new group of students is recruited and trained every four months.

"Museum to Go"

The Boston Museum of Science, the Chicago Museum of Science and Industry, and the Franklin Institute are among the many science centers that have initiated outreach programs to bring the museum world to the classroom. At the Franklin Institute, the focus of the outreach program, called

"Museum to Go," is to provide the Philadelphia schools with materials to implement an elementary science program that puts student-conducted investigation at the core.

> School districts across the nation have been implementing demanding and comprehensive new elementary science curricula that incorporate a 'hands-on' rather than a textbook approach . . . . As programs become more sophisticated, however, the need for low-cost, convenient materials and accompanying teacher preparation programs has become apparent. Museum to Go is addressing this need by producing science activity kits for grades K–9 that are easy for teachers and students to understand and use, and by providing teachers of all grades with opportunities to improve their scientific knowledge and activity-based teaching skills. [26]

The program was created in 1983, in close cooperation with the Philadelphia Public Schools and the Philadelphia Renaissance in Science and Mathematics (PRISM). In 1988, kits were in preparation on 28 different topics, including, for example, eight different exercises in meteorology. Materials are provided for children to measure air pressure, moisture in the air and rainfall; detect wind direction; find out about the heat-absorbing properties of light and dark materials; and figure out which materials (water, brick, plants, soil, etc.) absorb heat more quickly than others. Each kit contains enough material for a class to do the activities in small groups. There is also a teacher guide and instructions for the children. Other kits focus on such topics as electric currents and astronomy.

Museum to Go trains teachers to use the kits and provides follow-up support through the year. During 1988-89,800 teachers at grades five and six in Philadelphia are being provided with four science-activity kits, along with four corresponding familiarization workshops.

---

[26] Excerpt from a Franklin Institute brochure on the program (undated).

Institutes for Teachers

Recurring programs for teachers seem on their way to becoming an important feature of science-museum activities. A recent compilation by ASTC lists scores of sites around the country where teachers can attend workshops in biology, physics, mathematics, and other technical subjects. Summer workshops are offered on sexuality education in the museums of Charlotte, North Carolina. Programs for elementary-school teachers are featured at the Maryland Science Center in Baltimore, the Milwaukee Public Museum, the Oakland Museum, the Lawrence Hall of Science, the Buhl Science Center in Pittsburgh, the Science Museum of Virginia in Richmond, the Oregon Museum of Science and Industry, the Museum of Science and Industry in Chicago, the Buffalo Museum of Science, and at many other places.

The Exploratorium's Teacher Institute was launched in 1984 with the support of the National Science Foundation. It includes summer institutes, after-school programs, and weekend workshops. By 1987, it had served more than 400 teachers in the San Francisco Bay Area. Programs have been conducted on such topics as light and color, electricity and magnetism, sound and hearing, and vision and visual perception. The programs are intensive, with participants spending more than 100 hours in the museum over a period of months and, sometimes, years.

In a comprehensive, independent evaluation of the program completed in 1987 [27], teachers reported that the Institute helped them to relate "the abstract concepts of the texts and the phenomena of the everyday world." One said, "I'm more willing to try things. I'm not so worried about making a mistake and not having it go exactly the way it's supposed to go, . . . I allowed students to ask more questions."

---

[27] Mark St. John, *An Assessment of the Exploratorium Teacher Institute Summary of Findings.* Inverness, CA: Inverness Research Associates, 1987.

Asked about the positive and distinctive features of the Exploratorium's Teacher Institute, the evaluators, who had used "focus-group" and individual interviews as well as survey techniques, stressed the fact that the museum is a "neutral arena." It is a voluntary community of professionals where high-quality science is featured. Partly because of the amount of time teachers spend there, there is a sense of membership on the part of participants; long-term relationships are developed and valued. The evaluators also commented on the "clear vision" of science offered by the Exploratorium—the fact that the staff has a philosophy, an "Exploratorium approach" that goes beyond "content and basic skills." Said one teacher, "You have the opportunity here at the Exploratorium to play around with things, look around the corner. If the concepts are fuzzy, you can figure things out on your own—then you have a better understanding."

Some Dilemmas for Science Museums

In connection with a study of National Science Foundation initiatives in informal science education, SRI International convened a group of senior museum staff to discuss the potential and some of the problems associated with programs that link their institutions with school districts. While underscoring the contributions that museums should make, do make, and can make to improvement of school-centered science instruction, the group also highlighted some difficulties.

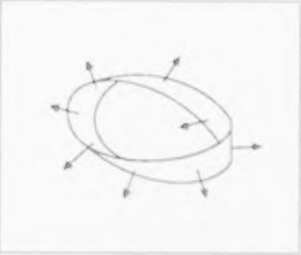
In addition to such barriers to collaboration as serious logistical and transportation problems, the lack of a teacher-education background on the part of many museum staff, and the limited physical capacity of many museums—all of which are real and important problems—the SRI Report[28] emphasizes the deeper dilemma of trying to enhance cooperation between two types of institutions that may appear to have similar aims, but that, in fact, reflect quite separate traditions and cultures. Museums and schools both try to educate, but they have come to have differing views of the process, and of science.

---

[28] See Michael S. Knapp, et al., AN APPROACH TO ASSESSING INITIATIVES IN SCIENCE EDUCATION, Volume 2: Pilot Assessment of the National Science Foundation's Investments in Informal Science Education. Menlo Park, CA: SRI International, 1988.

In the recent evolution of science centers, the emphasis has been on informality and playfulness. The aim is to fascinate, to stimulate interest, to evoke feelings of wonder. In the process, visitors are helped to develop and refine their understanding of science. Almost necessarily, the museum focuses on the dramatic and the visual. Schools, on the other hand, traditionally carry the responsibility of teaching about the various disciplines as those various subjects are currently conceived. High schools teach biology, chemistry, earth science, and physics. There is a tradition and an expectation that schools will present a comprehensive view of these subjects. Such an inclusive goal means emphasizing many concepts that do not lend themselves readily to visual display, or even to "hands-on" approaches. It also has come to mean careful attention in schools to sequence and continuity—not a strength of museum-based exhibits.

Is there a danger that forging linkages beyond a certain point vitiates some of the special strengths of both institutions? School-based learning should not be entirely episodic, even though it would be a good thing if more of the curriculum were playful and investigatory. On the other hand, museums do not build on their greatest strengths if they redirect more than a certain amount of their resources to priorities that are generated by other agencies. "How do you maintain your own integrity?" asks Lynn Rankin of the Exploratorium. "The school defines what is to be taught. We [the museum] have to know our own philosophy—and find a balance."



· 5 ·

"THIRD-PARTY" AGENCIES: BROKERS FOR CHANGE

Many of the cooperative programs to improve science education that we visited were stimulated, and in many cases they are conducted, by newly established, not-for-profit organizations outside the school system. For example, the Los Angeles Educational Partnership (LAEP) was an instrumental agent in the planning of the Westchester High School/Orville Wright Junior High School aerospace magnet school near the international airport. Often these organizations are created for the express purpose of providing support for and stimulating change in the schools. They raise funds, identify people who might be helpful in improving science teaching (as well as other subjects), and, at the sites we visited, often take the lead in designing collaborative programs.

One of their chief functions is to serve as intermediary and "broker" in matching the interests and needs of those in the schools with scientists and scientific agencies in the broader community. They serve as bridging agents between the schools and science-based institutions with which the schools do not ordinarily work, often operating in ways that are difficult for school districts.

For one thing, it takes additional organizational energy to nurture new relationships, to develop clear pictures of what each party has to offer. Few school districts have the luxury of staff with enough unassigned time for such functions.

Novel, collaborative activities also require trust. A third party can depoliticize the initial stages of a new inter-institutional venture. The staff of the cooperating institutions are less likely to search for hidden and potentially suspect motives in a third party than if familiar figures in their own organizations were in the lead. In the latter case, the steps toward the cooperative program with another agency might be confounded with the broader responsibilities of that person within the school district, university, or corporation.

Moreover, the third-party agency does not have a strong stake in the traditional, on-going programs. Sitting apart from institutions that usually are preoccupied with sustaining existing activities and with quality control, the third party can more easily look for novel relationships that will lead to new lines of development for school programs, bringing people together from many organizations to cooperate in striving for a common goal.

The Colorado Alliance for Science

The Colorado Alliance for Science, a state-wide organization, is one of the first comprehensive efforts to mobilize a broad array of participants from public and private sectors to improve science education. It may be the largest example of such collaboration in the country, currently numbering about 70 agencies, plus individuals.

Today the Alliance relies heavily on dues to advance its work, ranging from $10,000 per year from "host" colleges and universities that help to coordinate and administer the Alliance and serve as sites for many Alliance activities, to

$2,500 for "major" corporations like Coors, AT&T, Gates Rubber, Hewlett Packard, and Martin Marrietta; to $500 per year from participating community colleges, to $25 for individuals. Additional funding is provided by private foundations and individual donations. In 1988, the annual budget was $440,000.

Additionally, several of the corporations and universities contribute personnel "on loan" to the Alliance, and those resources are independent of the dues structure. The work for the Alliance of Norman Vlass, of Hewlett-Packard, and Jim Hubbard, from IBM, already has been cited.

Today the Alliance sponsors workshops for teachers and administrators that are presented by some of its corporate members, conducts a summer-fellowship program for science teachers funded by business and industry in the state, and coordinates a visiting scientist program that enables scientists from industry and government laboratories to work in partnership with science teachers, in pairs, to improve specific facets of the science program in elementary or secondary schools.

An Alliance-sponsored Retired Educators, Scientists, and Engineers Task Team (RESETT) enables the energies and abilities of older scientists to be channeled toward schools. RESETT scientists and engineers help students with science fair projects, consult with teachers, and, occasionally serve as speakers in schools.

The Alliance also supported a team of experienced teachers to develop policy recommendations for improvement of science education in Colorado. Their publication, *Conditions for Science Teaching—A Report of Policy Recommendations Formulated by the Colorado Blue Ribbon Commission on Science Teaching*, released in 1986, stressed the importance of student motivation, critical-thinking skills, improved problem-solving ability, and access to career information. The Report, which received considerable public attention and discussion, served as a stimulus for legislative and local action.

The Alliance is sensitive to the importance of improving science education in rural areas—in Colorado, as in other states, a powerful political issue as well as a pressing and difficult educational matter. Project LINK (Linking Institutions for Networking and Knowledge), part of the Alliance, encourages the pooling of resources in remote schools in the San Luis Valley of south-central Colorado, and the delivery of resources from industry and government to those schools. The San Luis Valley is surrounded on three sides by mountain ranges that rise to more that 14,000 feet. The economy is agricultural. Nearly 50 per cent of the population of the Valley is Hispanic. Eight of its 14 school districts fall below poverty level.

The Alliance program is directed toward developing working teams in each of the Valley's fourteen school districts to present in-service education. The focus is on the elementary grades. The teams are strengthened by a resource center, called the Science Cooperative, located at Adams State College in Alamosa. ("Cooperatives" are well-known and popular in rural regions.) Resources are provided by Alliance staff, by Adams State and the Colorado School of Mines, and by several corporate and government agencies: the federal government's Bureau of Land Management, Hewlett-Packard, Colorado's Division of Wildlife, the Public Service Company of Alamosa, the Colorado Seed Company, San Luis Water and Sanitation, the Alamosa Veterinary Clinic in Monte Vista, the Homestake Mining Company, the Farming Technology Corporation, the Conejos County Commissioners, and two dozen other agencies in the Valley.

Perhaps an important aspect of the Alliance's success is the fact that the Colorado Constitution contains an unusual provision that explicitly prohibits the legislature from determining curriculum. In almost all other states, curricular matters have become a major feature of state-government involvement in recent years. (Historically, curriculum responsibility had devolved to local levels in most places, but has been pulled back assertively to state level in the 1980s.) Colorado, however, with its constitutional prohibition, still relies heavily on local leadership. Thus, an important niche might be filled by an Alliance *without* governmental responsibilities or powers that can offer leadership but not impose it.

The initiative for the Alliance came in late 1982 from Manert Kennedy, then Director of the Center for Education in Science, Technology, and Society at the University of Colorado, Boulder, and formerly Associate Director of the Biological Sciences Curriculum Study, one of the major curriculum projects supported in the 1960s by the National Science Foundation. At an informal gathering of the Colorado Science Supervisors' Association, he proposed that an organization be established involving universities in the state, industry, and government laboratories to enhance cooperative activities to improve science teaching Colorado's schools.

Harrison Shull, then Chancellor of the University of Colorado, Boulder, was enthusiastic about the concept, and, in May 1983, the Colorado Alliance was launched jointly by the University and the Colorado Science Supervisors' Association. Shull arranged for the University to provide the initial funding, and he arranged also for the University to be the fiscal agent for the Alliance. Manert Kennedy was appointed Executive Director.

One of the first activities was a series of five half-day meetings to enlist assistance from teachers, government laboratories, business executives, and other universities. About thirty people attended each session. At these meetings, participants learned about the plans, offered suggestions, and, in significant measure, agreed to join in the effort. Right at the start, it was considered essential to involve all universities in the state, as well as key figures from the corporate world, and, during the following months, major activities were decentralized and Alliance sites established at Colorado State University, Metropolitan State College (in Denver), the Colorado School of Mines, the University of Northern Colorado, Adams State College, Colorado Mountain College, and Western State College. An associate director of the Alliance serves at each of these institutions. Kennedy is at Boulder.

Education Funds

Public education funds are recent creations that serve as bridges between the public school system and the broader community. Some of the work of the Los Angeles Educational Partnership, the Science Collaborative (part of Target 90) in San Antonio, and PRISM (in Philadelphia) already has been cited. The funds are non-profit organizations, under Internal Revenue Service regulations for 501 (c) (3) corporations.

At a major meeting in 1982 that provided significant impetus for the expansion of these new organizations, Francis Keppel, former United States Commissioner of Education and former Dean of Harvard's Graduate School of Education, said:

> We are . . . seeing now a tremendous change in resources potentially available to the schools. I am not speaking now just of money, but of the availability of communities throughout the United States, of activities in business, museums, and the service sector. But for these resources to be utilized, there must be the initiative to pull things together—an intermediary serving as a bridge. We are now seeing in the school foundation movement the establishment of new institutions whose focus is on

creating that bridge, or link, between the schools and the larger community and its resources. [29]

The San Francisco Education Fund, one of the oldest of the group, dates only from 1979. The Allegheny Conference Education Fund (in Pittsburgh) also was established in 1979. Now, there are scores of funds, stimulated, in part, by a temporary, national organization, The Public Education Fund, that existed from 1983 to the end of 1987 for the express purpose of launching new, local education funds and providing start-up assistance.

The Public Education Fund network of about 50 local funds, including the funds highlighted in this report, focuses primarily on urban areas, especially those with large concentrations of minority-group students. They are thus distinguished from the organizations with similar names that have arisen recently in wealthier communities and that primarily raise money from parents to supplement tax-supported dollars and programs. "Foundations for schools have an obligation *not* to use their funds to substitute or to replace what public funds ought to provide, not only in dollars, but in the uses of funds. Foundations for schools should *not* be efforts to fill gaps in public funding or to replace tax generated resources," according to Edward J. Meade, Jr., Chief Program Officer at the Ford Foundation and an influential figure in the early development of public education funds. [30]

The most visible and extensive activities in the early days of the San Francisco and Allegheny Conference Education

---

[29] "Private Sector Commitment to the Public Schools," *Works in Progress: A Report of the School Foundation Movement Conference, October 25–27, 1982.* San Francisco: San Francisco Education Fund, 1983, pp. 8, 9.

[30] "Needed: Local Support for School-Based Initiatives," *Works in Progress*, pp. 6, 7.

Funds were programs of direct "mini-grants" to teachers. Teachers usually have no discretionary funds. If they need something quickly that isn't readily available in the building, like electrical wire of a certain gauge to demonstrate how a fuse works, the usual practice is to go to a hardware store and make the purchase. Typically, there is no provision for reimbursement. The only alternative to a teacher's incurring the expense personally is to have anticipated the need for the wire about a year in advance and to have incorporated the item in the annual budget request.

Mini-grants, on the other hand (typically about $500, though some are $2,000 or more), are obtained from education funds quickly, and usually on the basis of a simple one-page request. Not surprisingly, mini-grants have proved an effective method for the local fund to establish almost-instant popularity in the schools. They also reflect an early priority of the funds, and one that generally has persisted as these organizations matured and began establishing more-programmatic ventures. Speaking at the formative 1982 conference, Gladys Thacher, Executive Director of the San Francisco Education Fund and one of the influential shapers of the fund concept, said, "Two notions [about education funds] were, and still are, central to our vision: the first is that community-raised funds should bypass the political process; the second is that teachers are the ones we need to reach first."[31]

Private, philanthropic foundations have been the major source of funds for the local education funds in recent years, their contributions amounting to about 35 per cent of all education-fund income. The business community contributed about 19 per cent. The national Public Education Fund itself provided about 17 per cent of income, with the remainder coming from "other non-profit organizations, individuals, school districts, and investments."[32]

---

[31] "The San Francisco Education Fund," *Works in Progress*, p. 11.

As public education funds matured, many of them expanded beyond their direct grants-to-teachers awards and began to take the lead in programmatic ventures to improve teacher education and curriculum, system-wide. These more-ambitious and deeper initiatives often have been undertaken with the support of large, national foundations. Ford, the philanthropic foundation most responsible for the local-education-fund concept in the first place, embarked on a program of grants, many to education funds, to create collaborative programs to improve mathematics education. Carnegie supported many inter-institutional collaboratives in science through local funds—for example, those in Los Angeles, Philadelphia, San Antonio, San Francisco, and Cleveland that are highlighted in this report.

In some local funds, however, there are mixed feelings about actually operating large programs, as against helping to plan and initiate them. When the Ford Foundation expressed interest in funding an urban math-collaborative in Los Angeles, it went for assistance to the Los Angeles Educational Partnership. The LAEP was greatly interested and brought prospective participants together to develop plans. Once LAEP leadership had completed its brokering role, however, it had intended to help create a separate organization to run the program. The Ford Foundation vetoed the idea, insisting that the LAEP be the responsible fiscal agent. Then the Rockefeller Foundation came along with a program for LAEP in the humanities, followed quickly by Carnegie with the idea for a science collaborative.

---

[32] Paul Natchigal, Toni Haas, Kent McGuire, Milbrey McLaughlin, "The Public Education Fund Five Year Evaluation Report." Pittsburgh: Public Education Fund, Forthcoming. (This report contains descriptions of the origins of many local funds and an analysis of leadership.)

David Abel of the Board of Directors of the Los Angeles Educational Partnership fears that the resources of the LAEP could be locked up undesirably in ongoing activities. LAEP's Executive Director, Peggy Funkhouser, shares some of these anxieties. The unique strength of local funds may be to ferret out new opportunities and bring the necessary people together to get them started, she believes. Accepting large-scale administrative responsibilities for hiring staff and conducting programs may be counter-productive. On the other hand, Funkhouser points out, education funds probably have to operate some programs directly to gain necessary visibility, credibility, and—ultimately—funding. Striking the right balance between conducting educational operations and brokering them is a sensitive and difficult matter, when the goal is to maximize the continuing and long-term influence of the funds as agents for educational reform.

An Elementary Magnet-School for Science

Magnet schools are not rare, since they represent one of the most effective approaches to mitigating deeply ingrained patterns of racial segregation in large cities. It has been demonstrated repeatedly that if an attractive educational program is created, parents and children will choose to participate in that program, even if the school is far from home. Nor are science magnet schools uncommon, at least at the secondary school level. More unusual is the science magnet school at the elementary school—and, rarer still, is the elementary science magnet that specializes in some particular facet of science. Such a school exists in San Francisco.

As part of the court-designed city-wide desegregation plan, the San Francisco Unified School District decided to transform its Fairmount Elementary School into a place where marine science would be the central theme. In doing so, it received support in the form of curriculum and teacher-education assistance from the San Francisco Education Fund, the California Academy of Sciences, and San Francisco's Steinhart Aquarium.

Fairmount opened as a marine-science magnet in September 1987, with assurance of two years of start-up, supplementary funding provided under terms of the desegregation plan. The magnet attracts about 500 students from kindergarten through grade five, roughly 35 per cent of them Hispanic and 40 per cent Black.

A special marine-science resource teacher was identified and assigned full-time to Fairmount to work directly with the children and also to provide assistance to the grade-level teachers as they incorporated topics and concepts from the marine sciences into their programs in writing, mathematics, art, music, and social studies. The school capitalized on special habitat-oriented curriculum materials that had been developed by the San Francisco Chapter of the Oceanic Society as part of their Project OCEAN. Additionally, Fairmount entered into an agreement whereby the Society provided in-service education for the teachers.

The program at Fairmount began with an ambitious schedule of field trips to the coast and to aquariums and museums, made possible by the availability of desegregation funds. Though San Francisco is on the Pacific, at the tip of a peninsula, and Fairmount itself is only five miles from the ocean, the staff at the school estimates that before the conversion of Fairmount to a marine-sciences magnet, more than half of the children had never seen the ocean. Classes visited tidepools, watched whales, observed elephant seals on the beach at Año Nuevo (about 30 miles away), and took advantage of educational opportunities at aquariums in San Francisco and Monterey. As part of a coastal clean-up campaign in Northern California, some of the children worked for several hours at Sloat Beach, a sheltered cove within the city.

At Fairmount itself, the center of the program is a newly designed Marine Science Laboratory, in which the children keep live specimens for observations and experiments: algae, crabs, seaweed, kelp, and squid, for example. They learn the physical characteristics of salt and fresh water, figure out how beaches are formed and change, and trace food chains. In each grade, the children focus on a particular habitat during the course of the year to learn about interdependence and adaptation of the plants and animals. In art and music, they draw pictures of marine organisms and learn songs about sea life. The children write and read about the organisms they observe and collect. They learn about their life cycles and economic importance, about conservation and management.

A major challenge is to put the program on a solid enough basis to enable the staff to continue the marine-science emphasis after the seed funding disappears—and with it the special marine-science resource teacher, Anne Clemenza. Clemenza sees it as her job to develop the Laboratory and help bring the teachers to a level that will make it possible for Fairmount to put the program on a permanent footing using regularly available funds. For example, she teaches fourth graders to maintain a salt-water aquarium, so that they can take on that responsibility when they are fifth graders and Clemenza will no longer be there.

Clemenza is one of San Francisco's mentor elementary-school teachers (considered by district administrators and her colleagues as one of the best teachers in the city) and an active participant in the San Francisco Education Fund's Science Collaborative. As a classroom teacher, she had been attracted to science because she sees the subject as a potent vehicle for involving the children in "hands-on" learning.

A priority for Judith Coenen, Fairmount's principal, is to keep a high-quality program going beyond the period of special federal funding, and a major hurdle is assuring funds for field trips. "We can use Muni [San Francisco's public transportation system] to get around in the city. But we need to get the children down the coast, to the tide pools and to the Monterey Aquarium." Coenen is working with parents, with district-level staff, as well as with the San Francisco Education Fund, to identify possible sources of continuing support.

Francis Tywoniak, project director for magnet schools for San Francisco, emphasizes that federal regulations require school districts to assume responsibility for magnet schools after the two years of transitional, seed funding. The job is to piece together elements of various budget sources—state, district, federal, private—around an integrated program like Fairmount's. "It's not an ideal way to support a program, or an easy one," she says, "but it can be done. The San Francisco Education Fund, including its mini-grant program, is a big help."

Teaching Science to First Graders in East Los Angeles

Marie Hillary teaches first graders at the Humphreys Avenue School in Los Angeles. During a recent visit, the children in her class were busily engaged in raising caterpillars and learning about the life cycle and behavior of the painted-lady butterfly, an indigenous insect: Some children were watching them eat; others were talking about their growth; a few were reading about the changes that take place as butterflies pass through their pupal stage and become adults; two children were noting the differences between painted ladies and another species; one girl was drawing a picture of the adult butterfly. Activity in the classroom was serious and purposeful, yet animated and relaxed—with lots of conversation among the children (and between teacher and child) about the investigations they were doing.

In short, Hillary's class was like those of other first-grade teachers who take advantage of the role science can play in making children active agents in their own learning, and the positive attitudes about school work that flow from such a program. The six-year-olds were deeply engaged in investigations about butterflies—by direct observation, reading, and discussion. However, while Marie Hillary's class indeed was like those of other teachers who feel comfortable with science, there was a notable difference: The children and Hillary were carrying on all their discussions, and doing all their reading, in Spanish.

With many children in Los Angeles schools speaking only rudimentary English (and many speaking none at all), the district decided to teach certain subjects in the primary grades in the children's mother tongue. The objective of the bilingual program is to promote use of English, but to use the child's dominant language to teach certain important concepts—while English is being acquired during other parts of the school day. As the youngsters become more proficient in English, the subjects that initially are taught in Spanish, like science, shift to English. Such an approach does not impede the intellectual development of the children. It also improves their self-esteem because they do not see themselves always in settings in which they are the focus of remediation.

In the science class, only Spanish is spoken. In other subjects, instruction is in "sheltered" or "mainstream" English, usually by monolingual teachers; however, Spanish-speaking teacher aides are usually available to help children understand what's going on. By fifth grade, all subjects are taught in mainstream English for those children who started in the program when they began school.

Hillary says, "The Los Angeles Educational Partnership's Target Science project helps me obtain the materials I need for children to have first-hand experience." She is an active member of Target Science, a multi-pronged effort in several regions of the huge Los Angeles Unified School Distract, that includes linking teachers to scientists in industry, establishing an electronic network for teachers to communicate with one another quickly and easily, organizing workshops for elementary-school teachers, awarding mini-grants up to $1000 for high-school science teachers, establishing science centers at strategic locations in the district to review curriculum issues and provide seed funding for new programs, and conducting "family science" workshops for parents and children to foster the necessary support at home for activities in school.

Hillary is convinced that an important element in teaching any subject is to involve the parents, as a way of complementing activity in school. She regularly sends notices to parents to inform them of activities in school and tell them what they might do to get involved in science with their children, and follows up with a home visit if she senses that parents are not cooperating.

Teachers Teaching Teachers

Since 1982, The Woodrow Wilson National Fellowship Foundation has operated a program of leadership institutes for secondary-school teachers of chemistry, mathematics, and physics. At each four-week summer institute, about fifty teachers study a. Princeton University with university faculty chosen from all over the country to develop up-to-date materials, which they are then expected to share with colleagues in their home districts.

The concept is one of "teachers teaching teachers." As stated in one of the Foundation brochures, "Teachers make the final decisions about what will be taught in the classroom, and how . . . . A strong corps of teacher-leaders, given support and professional status, can improve the teaching of chemistry, mathematics, and physics through formal and informal teaching of hundreds of their peers."

About 80 per cent of the participants who attend the intensive summer institutes receive grants of up to $5,000 to conduct programs for teachers in their respective regions. This program, like the original institutes for high school teachers, was funded initially by the Camille and Henry Dreyfus Foundation. Some Dreyfus Board-members had visited the first summer institute, says Carolyn Q. Wilson, the Director of Planning and Development for the Fellowship Foundation, "and fell in love with the teachers."

As examples of regional projects in recent years, Annis Hapkowicz of Okemos High School in Michigan received a grant to give a one-hour presentation on the use of common household materials in junior high school chemistry at the Regional Convention of the National Science Teachers Association in Columbus, Ohio. James Sparks, chemistry teacher in Pana, Illinois, gave a six-hour "make and take" workshop on electronic chemistry. Carey Inouye, of Iolani High School in Honolulu, presented Saturday workshops on the physics of music. There were dozens of additional outreach efforts.

The Fellowship Foundation also conducts a summer program of "mini-institutes" at designated university "centers," each one lasting about a week. They are conducted by teachers who have participated in the four-week sessions at Princeton. Follow-up sessions are conducted during the academic year. In 1988, chemistry institutes on topics in bonding, equilibrium, kinetics, electrochemistry, periodicity, photochemistry, biochemistry, and microchemistry were offered at Ohio State University, Butler University, Emory University, Washington University in St. Louis, Bates College, the University of Houston, and seventeen additional sites. Ten institutes were conducted in physics—at Hollins College, the University of Missouri, Georgia Southern College, and other places—that highlighted themes on wave phenomena, classical mechanics using the air track, semiconductors, light and color theory, and musical acoustics.

In 1986, in concert with the Camille and Henry Dreyfus Foundation, the Woodrow Wilson National Fellowship Foundation began to sponsor local "Academic Alliances in Chemistry," designed to enhance colleagueship among teachers at all levels, the model being professional groups such as county medical societies or bar associations—and the scores of academic alliances that have arisen in foreign language teaching and history. Woodrow Wilson and Dreyfus offer assistance in launching an alliance by, for example, serving to identify and attract scientists from universities and locating sources of funding. A brochure describing the alliances states:

> Alliance members tailor their own agenda and objectives to meet needs defined by school and college faculty in the same discipline. They rely on their own collective resources for ideas. Each group, therefore, is different.
>
> Many collaboratives have been started by core groups, often as small as two or three faculty members who identify others who may be interested. Other alliances have grown large enough to subdivide into smaller groups, but typically they have between twelve and sixty-five members who meet monthly or bi-monthly. None requires large sums of money or extensive fund raising.
>
> All alliances share a fundamental similarity critical to their success: membership is open to faculty and administrators from ALL educational levels—university to elementary school in some cities, counties or regions—but only to those teaching or working in the same or

closely related disciplines.

While the Woodrow Wilson National Fellowship Foundation was started just after World War II to encourage people to enter college teaching, and now has awarded more than 18,000 fellowships at this level, it did not begin thinking seriously about pre-college programs until 1980. The early institutes, starting in 1982, tended to draw veterans of summer institutes of the 1960s that had been supported by the National Science Foundation. The 1960s programs were very popular among science teachers, and tens of thousands of them attended. Tuition was covered by NSF, and stipends were awarded for subsistence, the exact amount depending on the number of dependents for the participant. The Woodrow Wilson National Fellowship Foundation covers transportation costs for participants, room and board, and provides an additional $800 stipend for the four weeks.

Lots of support for pre-college programs is offered from Fellowship Foundation headquarters in Princeton, but it is non-prescriptive. Summer institute and outreach projects are designed by those who have central responsibility for conducting the programs. Information is exchanged, but only a brief report is required after completion of the outreach program.

Carolyn Wilson believes that some of the programs conducted by the Fellowship Foundation offer hints at what a more-stratified teaching profession might look like. Several groups have recommended that exceptionally strong teachers be given higher pay and greater responsibility. There is considerable interest in the work of the recently created National Board for Professional Teaching Standards. The Board is considering ways by which high levels of competence in teaching might be judged, and teachers who meet the established standards certified. Wilson thinks that the kind of teacher-leaders prepared in summer institutes, who might also be those certified by the Board, would be the "lead teachers" who conduct the mini-institutes.

Linking Community-Based Organizations

New Orleans' public school system is one of the most poorly funded districts in the nation. It currently spends about $2,200 per year per student, compared, for example, with $3,187 for the State of Louisiana as a whole (in 1986), and $3,619 in Iowa (also in 1986). (Louisiana ranked 38th in the nation that year. California, at $3,543, ranked 25th. New York ranked second, at $6,011, and Kentucky ranked 48th, at $2,486.) Salaries of $12,000 to $15,000 for teachers are common in New Orleans, with about $19,000 paid annually to those with a bachelor's degree who have taught for ten years. The national average for teachers in public schools in 1987 was $26,551, and rising rapidly. The Louisiana average was $20,054. [33]

The parochial-school system pre-dates the public in New Orleans, and a significant number of the Black middle-class sends its children to Catholic schools. However, the public-school system, with about 75,000 children enrolled, is almost 90 per cent Black.

The National Urban League, through its 112 affiliates around the country, like the one in New Orleans, conducts programs in health, social welfare, and education. At the 1985 Delegate Assembly of the National Urban League, education was declared the priority issue of the agency. Ninety-seven of the affiliates have professional staff and all have a governing board; all affiliates receive funds from the local United Way, and, on average, 30 per cent of the budget is from that source. About 90 of them conduct some sort of

---

33. All figures, except those from New Orleans, are from the United States Department of Education.

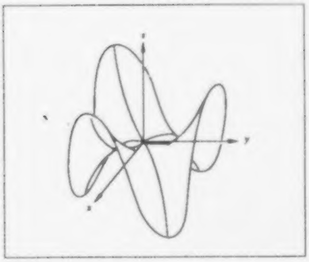
educational program. These programs are conducted, in part, by volunteers, some of them retired teachers. About 20 of the local affiliates, including the one in New Orleans, conduct special educational programs in science and mathematics for elementary- and secondary-school students.

The Urban League in New Orleans has established after-school tutorial programs in cooperation with selected Black churches. It conducts "street academies" during the summer to help young people pass the high-school equivalency examination. Classes are taught by certified teachers detailed by the public schools. It works with the Louisiana Nature and Science Center to develop programs that reach Black youth. With Southern University in New Orleans, it has established a community computer center.

The science programs were stimulated, in part, by the American Association for the Advancement of Science's (AAAS) "Linkages" Project. "Linkages" is part of AAAS's Office of Opportunities in Science, a unit with the general mission of increasing participation by members of minority groups, women, and the handicapped in science. The concept behind "Linkages" is to connect certain community-based organizations (CBOs) more closely to the scientific community for the purpose of improving opportunities in science for minority group members, women, and the handicapped. The focus is on students at the pre-college levels, their parents, teachers, counselors, and others who influence them.

The staff at Linkages tries to make CBOs aware of possibilities in science they might pursue, to demonstrate exemplary programs, to spread information about the problems and the ideas that work, to provide assistance in establishing and evaluating programs, and, the key approach, to bring scientists and science-rich organizations into association with the CBOs.

AAAS, as the largest organization of scientists in the country, is in a position, through its direct contacts and its reputation, to make scientists aware of the needs for improving science education. Linkages works regularly with groups like The College Board, the National Science Teachers Association, Women in Engineering, the National Society of Black Engineers, and the National Council of Teachers of Mathematics.


z
y
x

· 6 ·

WHEN A SCHOOL DISTRICT TAKES THE LEAD

The emphasis in this report so far has been on the role of third-party agencies and universities in stimulating and forging the relationships between school districts and other agencies to improve science education. These initiatives seem to be welcomed enthusiastically by school administrators in the districts we visited, but it does not appear that public school districts often take the lead in reaching out to other groups to design the kinds of collaborative programs described here.

There may be good reasons. Probably the most auspicious start for a collaborative activity occurs when the initiative comes from the better-endowed partner; commitment to significant cooperation can be assumed to be strongest, at least at the outset, from those who develop the idea. Furthermore, it isn't easy to enlist assistance from agencies that are not customarily involved in the education of young people.

Tom Paysant, Superintendent of the San Diego Unified School District, would like to forge closer ties to the corporate world, but his city does not have strong traditions of community involvement by local industrialists. No major, multinational corporations are headquartered in San Diego, though the district has benefited from involvement in education matters by personnel from the Navy, as has already been indicated. (In addition to the program that eases the way into a second career for retiring Navy officers, one admiral proved a rich resource for Paysant in examining the district's purchasing system.)

Paysant hopes that serious and continuing corporate interest in the schools will develop, and has encouraged the beginnings of a San Diego "Compact" that will explore and initiate programs. Paysant would like community leadership to emerge that will—on a steady, dependable, and informed basis—help the school district meet some of the issues it faces. To reach that level of involvement, it will be important for corporate executives to understand in some depth the relationship between the continuing development of San Diego and the strength of its educational system. Paysant and his staff can play a role in helping business leaders become better informed, but opportunities for doing so must be created. At present, leadership for the Compact is coming from the business community in the person of the Chairman of the Board of Directors of the San Diego Chamber of Commerce—an auspicious beginning, but only a beginning.

School administrators (and, occasionally, teachers), to be sure, are often active in civic organizations like the Rotary Club. They speak before the chamber of commerce when invited. They seem to participate broadly in adopt-a-school programs and an array of associations with nearby industry in connection with vocational education programs. They are deeply aware of the need for community support if schools are to function successfully. But rarely are the schools in the forefront in seeking out universities and industry to join on a collegial basis with teachers and school administrators to improve education in science.

The Pittsburgh Science Institute

The Pittsburgh Public Schools system is one of the exceptions. In 1983, the morale of science teachers in the district seemed particularly low. Responsible members of the community and the press were highly critical of the education system and of teachers. Teachers themselves felt that the curriculum was inadequate, that students were not learning, and that they were forced to work with outdated equipment, and, even that, in insufficient quantity. Even worse, many of the teachers believed there was little they could do to fix things, that they had little control over what was happening.

Doris Litman, who chaired the Science Department and taught biology at Allderdice High School at the time, "hated to hear complaining all the time." An optimistic woman, she organized a district-wide discussion group of science teachers to help those who came to search for ways to change things. Not many came, probably because of the low morale, but representatives did show up from eight high schools of the city's twelve. "We have a superintendent who listens," she said. "Let's do something about science." The group met five times and ultimately developed a position paper as a framework to improve science teaching in Pittsburgh.

One suggestion in the paper, which later became a proposal to the Superintendent of Schools, Richard C. Wallace, Jr., was to establish a Pittsburgh Science Institute that would focus attention on science education "by all those concerned with, or dependent on, a scientifically literate citizenry." The position paper sent to the Board identified "teachers as critical instructional decision-makers who need support and collaboration from the community they serve."

Wallace convened a group of thirty scientists in the area to review the recommendation, and, in 1984, this group endorsed the establishment of the Institute. The Fisher Fund (a family foundation associated with Fisher Scientific) awarded a grant of $120,000 to launch the enterprise, stipulating that the Institute should have a special facility where teachers could come for in-service education programs and to work on special projects, and where a central staff could work on comprehensive programs to improve science education in the city. Space was duly identified on Ridge Avenue in a building owned by the school district, not far from the Buhl Science Museum.

Wallace and Associate Superintendent Stanley Herman made concerted efforts at the outset to involve the corporate community in the Institute. They had crucial assistance in this task from the Allegheny Conference on Community Development, a well-regarded organization that, among other functions, had been heavily involved with the schools in establishing the links in Pittsburgh's version of an adopt-a-school program. Tony Ryan, chief executive officer of Copperweld, organized a meeting of local CEOs that included executives from both multinational corporations based in Pittsburgh and "local" firms. Endorsement and support followed quickly. By 1988, the Institute's Executive Board included members from Duquesne Light, USX, Bell of Pennsylvania, Aluminum Corporation of America, Koppers Company, Fisher Scientific Corporation, and Pittsburgh Plate and Glass.

Corporate scientists have been involved in many aspects of the Institute's work. In one recent initiative, dozens of scientists have been visiting middle schools to talk about their work with students. Additionally, ALCOA has made it possible to expand work in the "Saturday Academies" to include secondary-school students. The Academies are monthly meetings for minority students that started with programs for children in grades two through eight.

The Pittsburgh Science Institute now conducts a full array of programs. (Indeed, the Institute is the agency responsible for science education in Pittsburgh Public Schools. Litman is Associate Director of Science—the top person in this field for the district—as well as Director of the Institute.) The Board of Education established a policy, partly with encouragement from the Science Institute, to require two hours per week for science instruction in the primary grades and about three hours per week in the intermediate grades. The Institute identified teachers from each elementary school, a total of 90, and provided 240 hours of special training for the new requirement. It also supplied the schools with the necessary equipment and supplies.

Seventy middle-school teachers participated in 75 hours of workshop activities conducted by the Institute to learn about "hands-on" approaches to the teaching of science, that is, approaches that would engage children directly in observation and experimentation. As a partial outgrowth of this initiative, teachers are now engaged in redesign of the middle-school science curriculum.

The Institute has several collaborative programs with nearby universities: Carlow College's Program for Improving Elementary Science, Carnegie Mellon University's Program to promote scientific and technical awareness in children and youth, a summer workshop program for science teachers at Duquesne University, and the University of Pittsburgh's Community of Scholars Workshops in Chemistry, Physics, Biology, Elementary, and Middle School Science.

There are many more programs: with the zoo, the National Geographic Society, Westinghouse Electric, and the Carnegie Museum of Natural History, for example.

There are two great strengths of district-managed programs. First, when a school district takes the lead, as has happened in Pittsburgh, the purpose of the collaborative work seems to be more focused. Someone has decided that the science work undertaken in cooperation with other institutions in the community is worth teaching. There is a general plan for science into which the collaborative work fits; it is less likely to be educationally marginal, as is often the case when third-party agencies take the lead. (We return to this problem of many of the collaboratives in an entire, subsequent chapter.)

Second, the partnership activities are more likely to become a continuing part of the school's program; that is, the collaborative work is more-easily "institutionalized" than is the case for projects stimulated and organized by third-party agencies. A school district usually has the necessary staff to assure that successful programs receive the support they need to stay in operation.

A shortcoming of a district's taking the initiative is embedded in the strengths: a school district is more committed than an outside agency to ongoing programs. It is less likely to be venturesome, to try something that may challenge long-established patterns of teaching and organizing the curriculum.

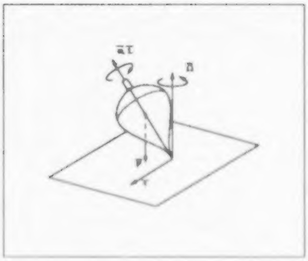
We do not wish to make more of this point than it is worth. The local education funds, and the other third-party agencies we saw, are carefully tuned to school district sensibilities. They could not operate effectively otherwise. And the Pittsburgh Science Institute actively seeks new inter-institutional connections; that's why we found it attractive. But as one contemplates the spread of inter-institutional collaboration, as new ventures are launched by more and perhaps less-experienced people, it seems important to be aware of the subtle and not-so-subtle differences associated with who is in charge.

Doris Litman offers some advice to those in school districts who wish to enlist other agencies in programs to improve science education. "Be sure you have the full backing of the superintendent, and go with something that is well thought out. Make sure you're talking about a *full* partnership. Find out what industry wants, and know the corporate culture," she says.

Litman herself was liaison person between Allderdice High School and ALCOA for three years, before she moved over to head the Pittsburgh Science Institute. In that capacity, she learned about ALCOA resources that might be useful to the school, and vice versa. She worked with ALCOA to match ALCOA interests with those of teachers at Allderdice. Some of the links she helped to establish led to summer employment for teachers. An English teacher took a position in technical writing. A physics teacher worked in one of the computer divisions, and taught ALCOA how considerable sums could be saved with use of different computer software.

She also learned that, for school/corporate partnerships to work, the chief executive officer of the company must make support for the link to schools apparent to colleagues in the company. She also discovered the importance of working with people positioned high enough in the company to have a global view of the resources that might be brought to bear on the challenge of improving the schools. "A corporation has as much difficulty getting communications across its divisions as a school district does," she says.

"It is essential to be clear about what the schools need. People in school districts sometimes don't realize that those in industry are held strictly accountable for funds. They aren't swimming in money." On the other hand, Litman reports, "those in industry discovered that the 'bottom line' is often easier to identify in a corporation than in a school district," that schools have a harder job assessing the results of their endeavors, and that, in a successful partnership, corporate ideas about costs and benefits are modified a bit.


ωt
Ω
F
r

· 7 ·

PROBLEM 1: WILL THE ALLIANCES LAST?

The collaborative activities we saw, as we said at the outset and as we hope we have demonstrated, are impressive. Sometimes they are inspiring because of the selflessness of some of the participants. Certain industrial scientists, at critical junctures in their careers, decide to spend many hours every week for several months helping to develop plans for a nearby magnet school; their work has an impact on thousands of children, for years. In other cities, researchers enter into "partnerships" with teachers that entail visits to classrooms, and that commit them to time-consuming work with young people as guides and counselors, as well as instructors.

Elsewhere, some scientists interrupt their corporate careers for a year or more, to "loan" themselves to agencies that are trying to improve elementary and secondary education; they help to secure funds and other resources for ambitious projects to improve science education, and sometimes take major managerial responsibilities for large projects and programs. University professors, at scores of campuses, take time away from the laboratory work and field investigations upon which their careers depend to work with teachers, children, and school administrators, often for weeks at a time; they change the professional lives of elementary and secondary school teachers, sometimes profoundly, by helping them to become part of the scientific community.

As a result, new worlds are opened to some students who, otherwise, probably would have drifted academically and occupationally. Receptive teachers reach new levels of colleagueship and effectiveness. Given the salutary results of the collaborative activities, and we think there is little doubt that everyone benefited in the programs we saw, an overriding issue becomes one of stability and longevity for these novel enterprises. Are they likely to be around five years from now, to outlast the current energetic generation of innovators?

We think there is cause for concern. Despite the unquestionable benefits that accrue, and regardless of the unmistakable enthusiasm, the existing programs seem fragile. Why?

Grass Roots and Greener Grass

First, the collaborative activities that are springing up all over the country that bring scientists together with teachers and students are emphatically local. That feature, in fact, is one of their major strengths. They are designed to respond to particular educational needs and opportunities by identifying nearby resources, and they are conceived and galvanized by people of extraordinary talent who know, and know how to operate within, the local political and educational structure. It seems to us that American education has not seen so extensive a grass-roots movement of the type reflected by the inter-institutional educational collaborative projects during this century—and certainly not since World War II (the period during which both of us have been professionally active).

Grass-roots efforts draw their strength, substance, and commitment from local history, tradition, and people. Each program is exquisitely tuned and tailored to the surrounding community. They capitalize on circumstances and events that are unpredictable and unique: the availability of a particular building, the wealth of a certain corporation and the predisposition of its chief executive officer, the good will of a gifted fund-raiser. Furthermore, most of the programs we saw have arisen outside established institutional structures; that fact, too, seems to be part of their success. The programs are timely and responsive.

But grass-roots efforts, especially those that spring up outside familiar organizations, are very difficult to re-create elsewhere. In every location, a somewhat different constellation of people and opportunities exist, and new educational ideas and practices are not transplanted easily. At least two kinds of overt resistance often arise to educational initiatives developed elsewhere: (1) For something different to work in my community, a person will say, it has to be invented here; otherwise the necessary commitment is absent; and (2) The grass is greener in District X; that is, District X has this or that characteristic that is not found here: a particular superintendent, a certain science teacher, headquarters of a specific corporation.

There is at least one more-subtle factor militating against transfer of innovation: Creative people usually do not derive satisfaction from duplicating initiatives that have been designed elsewhere; the kinds of people we saw working endless days, weeks, and months to make something work may not be very good at following someone else's blueprints.

Permanent Volunteerism?

To a pronounced degree, collaborative work to improve science education is voluntary—on everyone's part. One's primary institutional affiliation and loyalty are to a school or school district for a teacher, to a firm for a corporate scientist, to a university and a discipline for a university professor.

Those who become involved in successful collaboration develop commitment to the new arrangement to improve science education, but it is usually their personal choice to do so. It is difficult to identify the factors that promote the continuation of the activity when the original participants move on—when the individual university professor goes back to her biomedical research, when the corporate scientist returns to his chemistry laboratory, and when the government wildlife manager moves back to his field station.

Furthermore, these scientists are engaging in activities for which there are few precedents. School-board membership, to suggest a contrast, is a time-honored and valuable way for someone concerned about education to express a sense of community responsibility and obligation to a familiar institution. When one runs for school board, commitment must be strong, but the nature of the challenge and the responsibility is fairly clear. Others have done it before; the territory has been mapped.

The collaborative activities we saw were both more private and riskier. Many of the efforts were as likely to go unnoticed and unremarked, within the person's organizational home, as to be recognized. With no track record for this type of work, and no accompanying set of expectations based on successes of the past, the programs run the risk of being ephemeral. Who knows about them? How? What are the chances of continuation of the program if there is no recognition by peers of the merit of one's contributions to improvement of the schools?

Collaborative activity to improve science education, then, runs the risk of falling into a category of purely voluntary "service," akin in some ways to charity. It depends on a hospitable climate, social conscience, and private dedication—not always a recipe for a stable, ongoing program of activities. Even if the setting is right with respect to the organizations involved, a private sense of social responsibility among dozens of people is a thin reed on which to institutionalize a program. Right now, education is prominent among national priorities. Perhaps it will be so for a long time. Still, it may be problematic to depend so heavily on volunteers.

Oakes, in a report on problems of inner-city schools, asks, "Can districts depend on the kindness of strangers?" She's not sure they can, and neither are some other observers of the business-in-education scene. [34]

Robert Kirkwood, Vice-president for Government Affairs for Hewlett-Packard, says, "Attractive as these programs are, these sorts of things come and go. They are very dependent on the people involved." Richard H. deLone, a progenitor of the Committee to Support Philadelphia Schools and a key figure in the creation of that city's science-centered PRISM project, emphasizes the beneficial nature of collaborative activity for the morale of teachers, particularly the better ones. He says, however, "Business is interested in a better labor force, and these partnerships are good for the economy in general. But [cooperative programs] are not justifiable in terms of returns to an individual company." While deLone underscores the importance of the "genuine altruism" that he sees in Philadelphia, he says, "Corporate money [for education] is fickle. It tends to run in cycles. And who can explain fashion?"

Can Schools Depend on Education Funds?

Third-party agencies play a key role in many of the most successful programs we visited. Some of them, like MESA, seem to be moving steadily toward an impressive level of stability.

---

[34] Jeannie Oakes, "Improving Inner-City Schools: Current Directions in Urban District Reform," Center for Policy Research in Education, 1987, pp. 46–49.

But we are not so sure about others, particularly the education funds. Will they be able to last in a form that keeps them strong, constructive, and influential? In a report on the Public Education Fund, a temporary national organization that existed from 1983 to the end of 1987 to support and provide assistance to local education funds, the authors point out:

> What's important to the success of a local education fund director . . . is the ability to read the community, to garner trust from private, non-profit, community and education sectors, tolerance for ambiguity and an extraordinarily high energy level . . . .
>
> The speed with which local education fund directors have been able to establish viable, visible organizations testifies to the importance of these personal qualities. The energy and skills required also raise concerns for the longer term. For one, burnout seems inevitable. The level of energy, attention and activity characteristic of most executive directors cannot be sustained in the long term. Second, it is questionable whether the individuals who have the special skills and contacts that have underwritten this generation of local education funds will be available to direct local funds in the future as opportunities for women erode the ranks of volunteers [most fund directors and many of the staff are female] and two-income families become the norm. [35]

Not the least of the problems in sustaining any alliances to improve science education is money. However, the education funds seem particularly vulnerable to financial calamity. In a recent five-year period, local education funds (in the group of thirty-five such organizations studied by Nachtigal and his colleagues) secured about 35 per cent of

---

35. Paul Natchigal, Toni Haas, Kent McGuire, Milbrey McLaughlin, "The Public Education Fund Five-Year Evaluation Report." Pittsburgh: Public Education Fund, pp. 82–83. (Forthcoming)

their income from the national philanthropic foundations. Two of the local funds, those in Los Angeles and San Francisco, received 62 per cent of their income during a three-year period from private foundations, primarily Ford and Carnegie.[36]

Can Collaboratives Depend on the Foundations?

Most foundations, including the larger ones, have their own priorities—increasingly focused on programs rather than "general support" for a concept or an organization. Thus, Carnegie awards grants for specific partnership programs in science, Ford in mathematics, Rockefeller Foundation in the humanities. The programs competing for support are described in proposals prepared by the prospective grantee, and dollars are requested for personnel and other purposes directly associated with the programmatic activity proposed. The foundation assumes that most of the "core" costs can be, even should be, provided from other sources.

There are many difficulties with such operating procedures from the point of view of the grantee. First, there must be a close match between foundation priorities and local desires. This correspondence was not a serious problem at the sites we visited during the times we were there. However, it is not unimaginable that a local education fund could be derailed from what it does best (capitalizing on neighborhood resources to improve the science program) if a large amount of its activity is devoted to figuring out and trying to accommodate to those far away who have the money—however sensitive the staff of a given foundation might be to the importance of site-specific concerns. The local education funds, and the other groups that have taken the lead in collaboration, are seldom independent enough financially to resist overtures that will bring them recognition and support; grants from the national foundations bring both.

---

[36] Natchigal, et al., pp. 42–44.

Second, a local education fund can become program-rich but core-function poor by gearing itself too closely to the national philanthropic foundations. An administrative and creative staff is needed to keep looking for fresh opportunities. There must continue to be a capacity to respond to unanticipated requests or offers. The ability to act quickly (at least by school district standards) characterizes the successful efforts we visited; a certain amount of apparent "slack" is therefore necessary in administrative and program capabilities. Almost every one of the places we visited, however, suffers from tremendous overload on the staff; there is far too much to do, given the available personnel.

Third, "venture enterprise" and capital is essential for third-party agencies to continue to provide leadership. They need to be able to try new things on the basis of unanticipated opportunity, or even informed hunch. Their great strength is to circumvent traditional organizational structures in an opportunistic and selective manner. This capability is severely blunted if it must depend disproportionately on programmatic philanthropy.

Fourth, the large, national philanthropic foundations provide a shaky platform for continuing operations. Priorities shift at the national foundations. There is often a change with a new director or president. Even with stability in that office, times change and targets for philanthropic efforts are modified accordingly.

Furthermore, a typical grant from Carnegie Corporation for a collaborative project in science education lasts for three years, though renewals are possible and are awarded. Foundations usually like to stimulate new ventures, nurture them for a while, then hope the necessary factors are in place for continuation of the activity. They expect the new efforts to be institutionalized, but it is difficult to make novel organizational arrangements permanent, even over a period of five or ten years. In every one of the third-party agencies we visited, there are deep worries about what will happen when the large grants run out.

Can Schools Depend on Universities?

Yale University's collaborative program with the City of New Haven is one of the most mature and impressive of the university-based programs we saw. Some of the university's most-able active and retired professors are providing courses for teachers. But that effective partnership operates in an organizationally marginal unit at Yale. That is, the program was not established in an existing school or department, nor does it have a permanent faculty. Indeed, it has no tenured professors, or even permanent staff, who have the express responsibility for designing and continuing the collaborative work.

Instead, the Yale-New Haven Teachers Institute was created outside existing organizational units at Yale. None exists there that could have been expected to take relationships with the schools of New Haven seriously. Yale's president at the time, A. Bartlett Giamatti, who was the major figure in creating the Institute, wanted to engage the university in educational programs to strengthen the surrounding community; so he created the Institute to do the job.

Giamatti is fond of saying that Yale was favored in its ability to establish a collaborative program with New Haven because it has no school of education. His implication, not without foundation, is that schools of education at research universities have their own agenda, and collaborative work to improve the local schools is not usually prominent on the list of priorities.

But instant organizations with no permanent staff can be terminated almost as easily as they are created. The Yale Teachers Institute relies heavily on the favorable attitudes of senior figures in the central administration. That administration continues to value the Institute, even since Giamatti left Yale to head the National League of Professional Baseball Teams, but it is difficult to predict what may happen if times get tougher at Yale, and precollegiate education no longer seems as important as it does now to university administrators and the temporary and volunteer staff they recruit.

Many of the collaborative activities we saw around the country involve regular departments and schools at universities: at Duquesne, at the University of Pittsburgh, at some of the campuses of the University of California, at Drexel, at Georgia Tech, and at many more. Sometimes it was a school or department of education, sometimes not. But there were administrators and professors in charge of the university's part of the collaborative work. They have regularized budgetary allotments; they routinely allocate resources for the projects we saw. Priorities can shift at these places, too, of course; but it seems to us that more powerful momentum operates for a university's participation in a collaborative when the politically more-powerful schools, departments, and professors argue for their continuation.

Basically, though, the question of the dependability of university involvement in local alliances depends more on intellectual criteria than organizational and budgetary considerations. More precisely, it depends on whether or not professors and their peers value work in and with the schools. The president's enthusiasm helps enormously, but it's not enough for the long haul.

At a research university, the decisions about who is hired and who is promoted are made by the professors themselves. An administrator can help set the tone. He or she has a strong voice about the budget. But the president does not select and promote the faculty; the faculty does.

Not many science departments will hire a tenure-line professor, or promote one, to work with local schools to improve science education. A few have done so. But that person either leads an anomalous existence in the department because research in the field is the requirement for promotion—or the person serves only temporarily, then moves back to scientific research.

Furthermore, there are difficulties peculiar to science in school/university collaboratives that emphasize the provision of special courses for teachers. When a university arranges for a professor to offer a course for teachers in neighboring school districts, the faculty member usually receives supplementary compensation. Sometimes, the additional salary is for work during the summer. Summer, however, is traditionally a time for scientists to work on their research (usually with funds from a foundation). The financial incentive for many science professors to teach teachers, therefore, is non-existent—which is quite unlike the situation for professors in the arts and humanities.

Moreover, according to Charles Long, Yale's Deputy Provost, "It is more difficult for Yale faculty to find common interests with high school teachers in science than in the humanities." A professor interested in the Orpheus theme has little difficulty identifying high school English teachers who would like to pursue the subject. Science research specialties, however, often seem to relate less comfortably to the work of high school science teaching; they seem more technical, specialized, and harder to connect to the broad principles that are emphasized in the curriculum.

The Special Case of Schools and Colleges of Education

In recent decades, the units at universities that were explicitly created to serve teachers and school administrators, the schools and departments of education, have been agonizing about their own crises. The most famous of them—in the 1960s, the 1970s, and into the 1980s—were cavalier toward the schools. The route to fame was to emphasize research in the social and behavioral sciences. [37] The most highly regarded professors in the best-known schools and departments of education contributed to theory in the "parent disciplines." It was hoped that such scholarship, eventually, might have implications for educational practice, but that complex transfer of thought to action was not usually of professorial concern.

Anthropologists studied schools as vehicles for "cultural transmission." Some sociologists found them interesting examples of "loosely coupled" organizations. Certain psychologists studied the "cognitive development" of the students; others their "achievement motivation." Political scientists examined the dynamics of "legitimation" of educational policies. Much of this work was rigorous and interesting. All of it reflected emerging concepts in the behavioral and social sciences. But it was left to teachers and school administrators to figure out how to use the results of that research to improve their daily work in schools.

There are signs in recent years that some of the focus for scholarship in schools and departments of education is turning more toward the schools as they actually operate, however. Some researchers are learning the intellectual challenge of dealing with the complex world of teaching and classrooms on its own terms, rather than studying that world only as it offers illustrations of various disciplinary theories. They are re-discovering Aristotle's belief, articulated more than 2000 years ago, that ethically enlightened action is the highest form of thought. Practical work with an intellectual and moral base (like teaching), as contrasted with more-abstract theorizing, is regaining intellectual respectability at universities, slowly. In the process, some professors are learning that teachers can be colleagues in, rather than subjects of, research. They are discovering that a teacher's practical wisdom can enrich scholarly insight.

---

[37] Harry Judge, AMERICAN GRADUATE SCHOOLS OF EDUCATION: A View From Abroad. New York: Ford Foundation, 1982.

Teacher education itself is undergoing a revival at the most prestigious universities. Many universities that abolished their programs in the 1970s, like Chicago and Harvard, are re-creating them in the late 1980s. At Stanford, teacher education enrollments dropped to fewer than thirty in 1979, and the faculty seriously considered dropping the program. That possibility gradually lost steam, though, and enrollments have now more than doubled in a revitalized and locally valued program.

One reason is that able students are again expressing interest in teaching careers. That increasing interest, in turn, seems to be one more consequence of the recognition that elementary and secondary education is important to the future of the country, as well as to the students who attend these institutions—and improving education is a worthy goal for the entire community.

If these trends persist, the likelihood is increased that university schools and departments of education will continue to seek out close associations with the schools. In the last analysis, however, the schools will remain an important focus for universities only if able students and faculty want to work there. And they will want to work there only if such activity brings intellectual and professional rewards. There have been encouraging developments in recent years for those who want schools and universities to be linked more closely; a heightened sense of public service by university administrators coincides with a rediscovery of the intellectual challenge and importance of doing practical work. It is still premature, however, to be confident about whether or not these developments offer a likely pattern for the next decade or two.

Economic Competitiveness as a Driving Force: The Whole Story?

We already have commented upon the sense of community responsibility that seems to motivate some of today's corporate activity in elementary and secondary education. Nevertheless, there is no mistaking the fact that the major justification by corporate leaders for involvement by their firms in the improvement of public schools is their concern for development of "human capital." America's work force is decreasing in size and increasing in its proportion of minority-group members. Industry depends on people.[38]

Owen Butler was Chairman of the Board of Proctor and Gamble Company until 1986. He also was the knowledgeable chairman of the CED committees that produced "INVESTING IN OUR CHILDREN: Business and the Public Schools" and "CHILDREN IN NEED: Investment Strategies for the Educationally Disadvantaged." He wrote, recently:

> The relationship between economic development and the quality of public school education is recognized as an issue of prime importance by CED. In recent years, CED has become increasingly concerned with the ability of American business to compete in world markets. The Committee's study of productivity trends showed that

---

[38] See, for example, the 19 September 1988 issue of *Business Week*, titled "Human Capital: The Decline of America's Work Force."

> the decline of educational standards in the United States, despite the existence of many fine schools, is linked to the nation's flagging economic competitiveness.[39]

Linked, yes. But to what degree? There surely is an important connection between industrial productivity and the kind of attitudes and abilities that Butler's committees at the CED have found to be most highly valued by business (responsibility, self-discipline, teamwork, skill in communication, etc.). And, yes, schools—with support in the community and more than a little help from home—can make a difference. The argument is strongest in the case of entry-level employees, but it applies to others as well. Furthermore, there are many jobs, at all levels, that have a significant base in scientific and quantitative thinking.

With respect, however, to the most highly educated technical professionals, it is not at all clear that there will be a shortage of scientists or engineers in the decades immediately ahead. Labor markets usually adjust to changing needs, even if slowly. If there is a shortage of highly trained people, the major cause well may be a decline in the size of the age cohort graduating from college, rather than a deficiency in the quality of elementary or secondary education.[40] (In that case, it is particularly important to encourage women and minority-group members to select and prepare for technical careers.)

Further clouding the precise connection between industrial productivity and the improvement of elementary and secondary education, recent analyses of the reasons underlying America's decline in economic competitiveness, and the resulting recommendations, do not always identify educational improvement as a priority. For example, John A. Young, President and Chief Executive Officer of the Hewlett-Packard Company, chooses to highlight the low status of manufacturing (as compared with marketing, finance, and general management) among executives of Fortune 500 companies.[41] George N. Hatsopoulos (Chairman of the Board and President of Thermo Electron Company), Paul R. Krugman (Professor of Economics at MIT), and Lawrence H. Summers (Professor of Economics at Harvard) emphasize the central importance of a sharp rise in U.S. savings.[42]

---

[39] Foreword in Marsha Levine and Roberta Trachtman (editors), AMERICAN BUSINESS AND THE PUBLIC SCHOOL: Case Studies of Corporate Involvement in Public Education. New York: Teachers College Press, 1988, p. ix.

[40] "Demographic Trends and the Scientific and Engineering Work Force: A Technical Memorandum." Washington, DC: Congress of the United States, Office of Technology Assessment, December, 1985.

Finally, there is some evidence the most academically talented, recent, high-school graduates are not choosing to major in technical fields as much as they did a decade earlier, despite the fact that their primary and secondary education prepares them for such work. A study of high school seniors who have taken the widely used SAT examination reveals that, since 1982, the proportion of the top-scoring 10 per cent selecting technical occupations has declined. The strongest students academically are more likely in recent years to choose to study business than science. (Such career choices include those who score well on the math portion of the SAT.) So, clearly, factors other than the quality of primary and secondary education have a major influence on the size of the professional work force in science.[43]

Why do we question the degree to which concern about America's economy drives today's pronounced interest by

---

41. "Technology and Competitiveness: A Key to the Economic Future of the United States," *Science*, 15 July 1988, Vol. 241, pp. 313–316.

42. "U.S. Competitiveness: Beyond the Trade Deficit," *Science*, 15 July 1988, Vol. 241, pp. 299–307.

43. Educational Testing Service, "New Studies Monitor Talent Flow into Technical Fields," ETS POLICY NOTES, Vol. 1, No. 1, July 1988, pp. 6, 7.

politicians and corporate leaders in improving the schools, in the face of unmistakable testimony from such people that it is a major factor? Perhaps it is wishful thinking, in the following sense: We worry about what might happen to American corporate interest in and dedication to the improvement of elementary and secondary education if elementary and secondary schools no longer seem so important to the economy, at least above a certain minimum educational level. We may be trying to find the reasons for justifying continued involvement in improvement of education by major science-rich institutions, if and when the public decides to mitigate current economic problems by other methods than improving the schools.

Thus, we choose to see corporate motivation as complex. We indeed see elements of self-interest, narrowly construed. No one who listens and reads can escape articulate and persuasive statements from political and corporate leaders about the need for educated human "capital." But we also think we note a genuine spirit of community service and altruism on the part of corporate America, and not a little patriotism. It's good for the country to have strong schools, and industry has a special role to play.

In the long run, however, corporate attitudes about education are likely to be little different from anyone else's. If the society at large values public education and is willing to invest in it, then so will corporate America. During the past decade, business has begun to find a significant role in making things better, and, if the public continues to commit itself to improving public schools, we believe the corporate community is likely to build on its demonstrated pockets of effectiveness, and remain an active force. That opinion, however, reflects the outlook of optimists; it is not universal.

Fragile, But the Movement Grows

Any one inter-institutional project to improve science education, and particularly those that are stimulated and nurtured by local education funds, lives a useful but precarious existence; its work clearly benefits teachers and children, but it is always looking for additional money to sustain and expand its programs. So is any organization, one might say. But these inter-institutional projects are still in an embryonic state, and usually there is no single and clearly identified institutional parent to bring the infant organization to mature independence. Not all collaborative activities are as successful as those we have seen in securing funds, and even those we saw spend a large fraction of their energies looking for money.

A paradox: Even if individual programs seem fragile, the collaborative movement continues to grow. The Triangle Coalition, part of whose responsibility it is to keep track of such things, enrolls several new members every month. The number of programs in science seems to have doubled in the last few years.

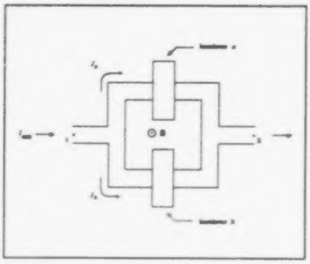
Clearly, there is something very attractive to local communities about the concept of collaboration to get a job done. More places want to try it, and do so. Dave Sugg of Target 90's Science Collaborative in San Antonio, says, "People like to collaborate. They like to work in groups. The only thing they need is a leader." The statement seems accurate, simple, clear, and wise, and the growth of the movement suggests that he is correct.

But some collaborative work falls by the wayside, even some big projects, despite good intentions and heroic effort. Greg Crosby of the Triangle Coalition, who monitors some of the failures as well as the successes, says that, even putting aside the challenge of funding, it is easy to overlook some key considerations that bear on the vigor, or even the existence, of a local alliance. "People are competitive," he reminds us. "One should not try to institutionalize a collaborative program through one's own organization. One university will not write a check to another. Also," he says, "some alliances are formalized before all the important people are in place. Then potential key contributors feel left out."

These comments suggest that there is something to be learned about the techniques necessary to build a vigorous and long-lasting program of collaborative work to improve science education. If the motivation comes naturally, if the benefits are clear, then it is important for those inclined to begin a program to be in a position to learn from the mistakes and successes of others if the movement is to stay on a firm footing.

Again, the Triangle Coalition sees itself as playing a useful consultative role. It also brings alliance leaders together, regularly, so that directors and others can share experiences. Generalizations can be glib and inapplicable locally. Personal associations often carry more meaning, as in any network of similarly inclined people.

Later in this report, there is consideration of some of the factors that seem to be in evidence at the successful collaboratives that we had the opportunity to visit. The delineation of effective practices is not exhaustive, though. No general set of considerations can be since local circumstance is so central to the kinds of collaborative programs we are trying to describe and encourage. In the last analysis, the longevity of the alliance movement will depend not only on continuing support in the community at large for public education, but on the degree to which people and institutions see the improvement of public education as a job for everyone.


B

· 8 ·

PROBLEM 2: WHAT SCIENCE SHOULD BE TAUGHT?

Almost all the science collaboratives we visited are, by their nature, opportunistic enterprises that are designed to capitalize quickly on the good will of non-traditional actors on the education scene, and on unanticipated circumstances. Those who direct these activities are masters of serendipity. A medical-clinic chemist expresses interest in high-school science in Cleveland. At Yale, a university researcher suggests that he is willing to offer a biology course for high school teachers. In Philadelphia, a museum director and his board decide to conduct intensive overnight workshops for teachers, and help prepare science kits for the elementary schools. In every case, an unconventional organization—often, but not invariably, outside of the longer-established institutions—is ready to help translate the constructive impulses into action.

Marginal Science

The great advantage of this style of operation is that it can be timely and give the participants a sense of relevance and excitement. A troubling problem in many instances, however, is that the resulting activities are at the margins of the basic program in science.

The alliance-fostered programs teach something. They often motivate the students. But they seldom build on the basic science program in the schools. That is, only infrequently are they designed either to add to the school's established curriculum, or to offer a worthy departure from it. Frequently, they are add-on and isolated projects, with their own life and momentum.

This characteristic of the collaborative work would not be objectionable if science programs in the United States were basically sound, and the most important need was for stimulating and important supplementary material. But the programs, for the most part, are not very good. Far from it. While there has been some improvement in student achievement in science in recent years, it has not matched earlier declines. The condition of science education is particularly unimpressive for members of minority groups and for girls.[44]

In most schools, students complete a course in biology, but most of them enroll for no further science. In elementary schools, on the average, science is taught for eighteen minutes a day.[45] The science that is taught is generally a reading and vocabulary lesson, with the students reciting back to the teacher the exact words of the text. There is very little investigation or field work at any level. At least as disturbing, the content selection itself, for the most part, has not been seriously examined in decades.

There are exceptions, like the magnet schools in Los Angeles and San Francisco we have described, where the

---

44. Ina V. S. Mullis and Lynn B. Jenkins, THE SCIENCE REPORT CARD: Elements of Risk and Recovery (Trends and Achievement Based on the 1986 National Assessment). Princeton, NJ: Educational Testing Service, 1988.

45. Iris Weiss, REPORT OF THE 1985–1986 NATIONAL SURVEY OF SCIENCE AND MATHEMATICS EDUCATION. Research Triangle Park, NC: Research Triangle Institute, 1987.

entire curriculum is significantly different as a result of the local alliances, or in Pittsburgh, where the collaborative work is built around the district's own course of study; but, mostly, the cooperative programs we saw are satellite enterprises, considerably removed from the center of gravity of the educational program. The essence of the science work, unfortunately, is usually embedded in a dated and uninspired textbook.

Bill Honig, Superintendent of Public Instruction for the State of California, voices his reservations about the work of the local alliances this way: "Keep the beauty of the local initiatives. But we must have some sense of where the State is [with respect to science]. We have to know where the holes are. Where are we strong? Where are we weak? We need enough definition of what the real [science education] needs of the schools are—and a general philosophy."

Honig puts his finger on a key issue. Under his leadership in California, considerable effort has gone into the preparation of a State science framework. It's a good one, especially given the state of current thinking about science education. Science teachers and supervisors from many parts of California gave serious attention to the identification of key principles in biology, earth sciences, and physical sciences—stressing both major scientific concepts and the processes that underlie scientific thought and investigation. The same procedures have been employed in many other states, as well.

But the local initiatives that we highlight in this volume do not map closely on a carefully crafted statewide or district-wide plan. At one level this fact is a non-issue, or, at best, a bureaucratic one. As long as sound science is taught, does it make much of a difference whether or not the statewide or district-level framework is the central guiding document? But at another level, the question is far from trivial: Does the educational content that is conveyed in the various alliances represent the most effective use of student and teacher time in the science program?

In a disappointingly small number of cases, we must report, the science that the children and teachers were studying provided evidence that Honig's concern is well-placed. While participants, almost without exception, were stimulated and engaged by what they were doing, the science selected sometimes sacrificed the important for the dramatic, deep and sequential study for the compelling episode, and instruction in basic concepts for the sake of timely, but shallow, discussion.

Science is sometimes dramatic. There are indeed compelling stories to tell. Scientific research does have timely implications for social and personal choices. All these factors deserve emphasis in a strong elementary or secondary school program, and every good teacher weaves them into his or her work with children. They are indeed motivating, and they relate science to topics that the students find important. What we found troublesome, however, is that, in too many cases, the work that was associated with the collaborative program bore little or no relationship to some broader conception of goals for the science program.

In the worst cases—of which, fortunately, we did not see many—it was difficult to detect *any* connection to the curriculum. The trip to an industrial plant in one city seemed to be considered a break from routine by students and teacher, rather than offering an opportunity, also, for enhancing understanding. Don Whitlow, Senior Vice President at ALCOA, says, "I'm concerned about some of the school-business relationships I see. There's got to be more to it than taking kids to the ball game, or even giving them a tour of the plant, and then giving them company hats. There's got to be more substance."

In a greater number of cases, even when the activity clearly had an educational purpose, the experience was isolated—like showing an educational film without preparation or follow-up. When the activity that resulted from work in the alliance was related to the larger purposes of the science curriculum, it wasn't always clear that that curriculum reflected careful thought about the most important science to teach. In short, the science activities sometimes contained very little conceptual meat. If not exactly educational junk food, the science was not particularly nourishing intellectually or personally.

The Need for Science Leadership

Science is an enormous and growing field. Most of the scientists who have ever lived are working today. Key contributions are made by the research community every month, and knowledge grows far beyond the bounds of what even experts and specialists can keep abreast of. Schools cannot teach everything.

The essential challenge for textbook writers, other curriculum developers, and teachers is to identify the content that is worth teaching and to present it in a fashion that reflects the spirit of science as well as its results. That's a tall order and a sophisticated task. Coverage of the field is impossible. Time in schools, however long, is limited. The choices for the curriculum should emphasize scientific concepts with the greatest intellectual and personal mileage, the ideas that have great explanatory power and the greatest meaning in the lives of the students. The job of choosing the most appropriate content cannot be done without the help of those who know the subject best, the most eminent scientists themselves (though it cannot be done by them alone).

Furthermore, many concepts in science are valuable for the student only if they are learned sequentially. It matters what comes first, and how those foundational ideas are conveyed and developed; otherwise later exposure to science is intellectually unanchored. Science is not taught best as a series of unconnected episodes, especially at the secondary school level (and the matter is debatable at the elementary school level). A certain understanding of the concept of mass is necessary before one deals intelligently with gravitation and space travel. It helps to know about species variation before attempting a discussion of adaptation and evolution. Plate tectonics bears a relationship to vulcanism and earthquakes. It is in the patterns and relationships that meaning and understanding emerge from otherwise-isolated science observations and facts.

During the last great burst of national effort to modify the science curriculum, in response to Sputnik, a vision of science and science teaching was projected by distinguished members of the scientific community itself. Indeed, a defining characteristic of the 1960s curriculum reform movement was the central involvement by a few dozen scientists who were at or close to Nobel Laureate stature. These men and women initially were attracted to the challenge of working on educational problems out of a sense of service: the schools needed help, and they could provide it.

As their participation continued, however, many of them became absorbed, often to their surprise, with the intellectual difficulty of identifying the content that is most worth emphasizing for children. To what extent should over-arching ideas of science, like randomness, symmetry, and equilibrium, be emphasized? What degree of substantiating evidence is required to teach these concepts, and how is it be acquired? What biology is basic, and what is primarily illustrative? All the scientists believed that there is an economy of ideas in their respective fields, but it was by no means intuitively obvious what those ideas are.

Rightly or wrongly, these people made some decisions about the science that should be taught in the schools—and told the world about them. Their choices guided curriculum development and influenced the textbooks. Different decisions would be made today (partly because the student body has changed, partly because the programs created then were largely inattentive to the impact of science on individuals and societies, partly because our ideas of science have changed), but the point is that a considered vision guided the development of the science-education reform movement 25 years ago.

For all the benefits of the 1960s curriculum work—and they were deep and significant—the clearest strategic error in the movement, in terms of its influence on the schools, was to fail to appreciate the importance of involving teachers in the development of the courses. There was sometimes a certain arrogance, bred of ignorance of the school system, among the scientists. They believed that what they did would be grasped eagerly by teachers (and sometimes it was); but the prime movers in many of the projects had little understanding of the dynamics of educational change. They had little appreciation of the sensitive and rapid decisions that must be made every day in the classroom as teachers try to cope not only with the subject matter, but also with the intricate task of relating that subject matter to the world of the students in their particular classrooms.

...All Dressed Up and No Place to Go

Today, many of the efforts that we saw to improve science education are suffering from exactly the opposite problem. Extraordinary and unprecedented coalitions are cropping up at the local level. In today's jargon, an impressive "infrastructure," or administrative-support system, is developing. Teachers are receiving welcome assistance. They are being involved, centrally, in steps to improve science education. They are being joined by other participants with the skills to make a real difference. There is a yeasty creativity and enthusiasm in the many communities we visited. Schools and their various constituents are ready for change, and they are taking constructive action. But a guiding vision of good science teaching is missing: many communities are all dressed up, with no place to go.

Taking nothing away from the scientists who are involved at the local level from industry, government, and universities in the alliances we saw, they cannot be expected to apply the amount of effort required for the tough job of basic curriculum design. They usually do not have the time. More importantly, there isn't the critical mass at the local level. For the task of curriculum building, scientists must be able to talk with one another, deliberatively *and* over a reasonably long period of time, to probe education issues with appropriate depth and sophistication. That job requires national impetus and nationally recruited scientists. The country doesn't need more than a few dozen at that level, but it needs them desperately.

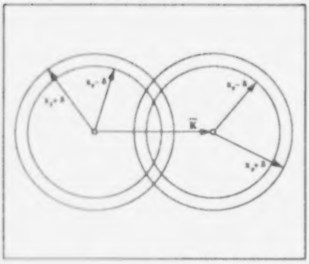
Our fear is that the collaborative movement in science education, as now constituted, will flow along with its own considerable momentum for several more years, carefully preparing the groundwork that can truly improve science teaching, but, before much more time has passed, an informed observer will take a hard look and say that the local efforts are heartening, but the essential framework for the science teaching may not be worth all the trouble.

It is necessary and possible, we believe, to avoid such a gloomy outcome, but leadership is required. That leadership was provided in the 1960s by the National Science Foundation, a federal agency that has the capability, and almost all the money, for research and development in science education below the collegiate level. Science education in that agency was decimated in the early 1980s, but the Congress has steadily increased its appropriations since then. The potential exists at NSF to fill the important gap for science leadership, and its own history provides basis for optimism.

Meanwhile, some organizations have stepped in to try to fill the role. Project 2061, mentioned at the beginning of this report, is an effort sponsored by the American Association for the Advancement of Science to identify the science that people should know by the end of their period of elementary and secondary education. Outstanding faculty in Stanford University's Program in Human Biology are working on a new life-science program for the middle grades, with the help of teachers and other science educators. At the moment, though, these activities are not yet having the impact on curriculum that they should. Local eagerness and capacity is outpacing national vision.

The national challenge is to avoid the extremes of top-down curriculum pronouncements, on the one hand, and solely grass-roots and opportunistic strategies, on the other. Both are needed. Both can happen. The ideal, we believe, is to provide guidelines that have been carefully worked out at state and national levels—that are then developed, expanded, and refined based on local skills, interests, and opportunity. Teachers must have the latitude to make choices that tailor the general goals of science teaching to the specific circumstances of the classroom, but they need a clear idea of where the science leads, and why they are teaching it in the first place.

We saw no lack of interest at the local level in working collaboratively with state and national groups. Quite the contrary. Right now, however, the national efforts are not visible enough, they are not operating on a sufficiently large scale, and there aren't enough of them.


$k_F+\delta$
$k_F-\delta$
$\bar{K}$
$k_F-\delta$
$k_F+\delta$

· 9 ·

WHAT WORKS: PRACTICES AND POLICIES THAT PROMOTE SCIENCE EDUCATION PARTNERSHIPS

Every strong collaborative effort to enhance science education that we saw enjoys deep commitment by able and dedicated people. There is a common goal that inspires and propels the activity, often a very general one (like improving the teaching of science or increasing enrollments of minority groups in science classes). Resources are required and secured. People feel free to try new ideas; local initiatives are sought out and supported. The work unfolds within an organizational framework that encourages the participants to work with new partners.

Are there lessons to be learned from the effective programs scattered around the country? Can people in other places who wish to try the collaborative idea, or enhance and expand it, learn from those with experience? Perhaps. But because collaboration of the intensity we observed is a relatively new phenomenon, there have been only a few attempts, so far, to propose guidelines for school districts that are contemplating the initiation of such programs. [46] Nor is there much help for governmental authorities at state or national levels, corporate leaders, teacher unions, philanthropic foundations, universities, or other agencies that may play an influential role. One barrier to developing a blueprint for success is that effective collaboration is exquisitely site-specific, as we have tried to point out. General advice is chancy because local people and opportunities make all the difference.

---

[46] See, for example, Marsha Levine and Roberta Trachtman (editors), AMERICAN BUSINESS AND THE PUBLIC SCHOOL: Case Studies of Corporate Involvement in Public Education. New York: Teachers College Press, 1988, pp. xxi, xxii.

Nevertheless, we offer some observations here that we hope will provide a useful context for people who care about these programs. Some of our comments are intended for local communities, but several are directed at influential people at other levels in the public and private sectors who bear responsibility for improving education, or who believe they can have a constructive role.

The fundamental factor that will sustain educational partnerships—though insufficient by itself—is a pervasive will on the part of the public at large to improve the schools. The conviction that public education is important, and that the country must invest heavily in its children, is a necessary backdrop for policy initiatives that stand a reasonable chance of strengthening local alliances.

Moreover, the view that better education is everyone's responsibility, and not only the job of teachers and school administrators, also must be sustained. Only then will the scientists in corporations, universities, and government laboratories continue novel and idiosyncratic collaborative enterprises in which they share their knowledge, time, and equipment with school districts.

Such a supportive climate for local alliances exists right now, but the history of educational reform suggests that it cannot be taken for granted. Steps must be taken to make sure that community receptivity does not change. One way is for leaders to speak out about the importance of both education and public-private ventures. In the 1988 presidential campaign, children and education emerged as important issues.

We hope that the President follows through with the rhetoric of the campaign. Governors, to an unprecedented degree, are staking out education as their top priority; their statements and actions are essential to sustain educational momentum.

The Committee for Economic Development continues to stress the importance of a strong system of public education and the responsibility of the business community to help. University presidents keep pressing for greater involvement by their faculties in addressing the problems of elementary and secondary education. On the schools side, union leaders and school superintendents continue to promote closer ties between public schools and other institutions.

All these people in leadership positions must persist in their public statements and ensuing actions if the local-alliance movement is not to lose momentum. For the initiatives to take root, secure support, and succeed, major figures in the private and public sectors must be sure that alliances and the improvement of education stay in the national spotlight. One way is through corporate, "public-service" advertising about the partnership programs *and* about the importance to the nation of able young people choosing careers in teaching.

We think there is a reasonable chance that leadership in governmental and corporate sectors will continue to stress the importance of education and the potential for public/private partnerships to make a difference. In fact, in a year and a half of visits to exemplary programs, we heard only one reservation about the educational and political merits of using the local alliances as a prominent feature of national strategy to improve science education. [47] It was voiced by Bill Honig, California's Superintendent of Public Instruction. We have already reported his concern about the quality of the science in many of the alliances, and we share that worry. But he also fears that the alliances may divert public attention from the main challenge in improving science education.

---

[47] We *did* hear skepticism about the staying-power of corporations and universities on the education scene, and we have tried to address that issue in an earlier chapter.

Honig, at a June 1988 meeting of Carnegie Corporation trustees, emphasized that local alliances touch only a small fraction of the students, and that they capture an incommensurate share of public attention. Honig must concern himself and his department with the state as a whole. He wants large-scale reform, and he is working hard for it. Local alliances may be interesting and suggestive, but he thinks it may be distracting to try to figure out how each local variation fits into, or can help shape, state educational policy. (There are more than 1000 school districts in California. One, in Siskiyou County, has seven students; Los Angeles has half a million.) Promoting local alliances may not be the best use of time and talent, Honig believes.

Just as problematic for him, the public may gain the impression of extensive improvement in science education because many of the collaborative programs capture media attention and are often portrayed glowingly. The successes of these localized projects may distract from the larger effort that is necessary to improve science education in all the districts and schools.

While these concerns have a realistic political, educational, and strategic basis, it seems to us that educational improvement should be valued and supported wherever it appears. Yes, the public should know that the local alliances are not yet mainstream educational practice, and they have their own problems, some of which we have tried to highlight [48]; but these

---

48. Another potential problem with the science partnerships: Leslie Siskin, of Stanford's Center for Research on the Context of Secondary Teaching, alerted us to the possibility that collaborative work in science, in the absence of similar activity in other fields, can lead to troublesome,

facts in no way lessen the impact of the partnerships on those fortunate enough to be involved.

More importantly, it is in the pockets of excellence that policy makers find the demonstrations of educational practices that are worth learning more about, and, possibly, emulating.

A "Bottom-Up" Strategy

One of the strongest features of the local alliances, as we have emphasized repeatedly, is that they are grass-roots efforts. They are conceived, developed, and operated within the local community, enlisting the help of a variety of institutions that have the resources to make a difference. This feature is the pivotal characteristic of the successful collaboration we saw. In suggesting a policy direction, we can do no better than to quote the Committee for Economic Development:

> A "BOTTOM-UP" STRATEGY
>
> Our recommendations form a "bottom-up" strategy that views the individual school as the place for meaningful improvements in quality and productivity. This strategy does not minimize the importance of states, localities, and the federal government in defining goals, setting priorities, and providing resources. Nor does it overlook the role that the state and local authorities must play when schools and school systems fail to meet minimum standards. The states should provide "top-down" guidance and support to local schools by establishing clear goals and high standards and by developing precise measuring tools to evaluate educational achievement. At the same time, the states should give the schools

---

inter-departmental resentment and rivalry within a high school. We were not sensitive to such an outcome during our visits, however, and the problem did not come to our attention.

> maximum freedom to develop and implement the methods that would best achieve those goals.[49]

Striking the right balance between state-level standard setting and local autonomy is tricky. We have pointed to the need for a greater national effort to identify the science that is most worth teaching; such a step is essential on today's science education reform scene. But significant educational change does not happen unless individual teachers are given the latitude to exercise their own best professional judgments.

The ideal is to find the best combination, but the path to that result is far from clear. Heavy, top-down prescription and regulation do not work. Local initiatives can be directionless. Errors will be made as the country tries to figure out how best to combine accountability with greater professionalism for teachers. If mistakes are inevitable, however, we would rather see them on the side of teacher autonomy and initiative at this particular point in the evolution of American education, than to press for more prescription and regulation.

In the end, schools will be only as effective as the teachers who staff them. Talented people want scope for their creativity. They want the trust and latitude accorded people who have a sense of service and responsibility—and know their jobs. Teaching, as an occupation, has been forced in the opposite direction in recent years, and an essential ingredient in making the field more attractive is to encourage teachers to take the lead in making things better.[50]

---

[49] CED, INVESTING IN OUR CHILDREN: BUSINESS AND THE PUBLIC SCHOOLS, 1985, p. 7.

[50] Fortunately, there is impressive effort to enhance the professionalism of teachers, most notably (among many other developments) the establishment of a vigorous and potentially influential National Board for Professional Teaching Standards.

Giving the teachers an appropriate level of professional responsibility, though absolutely necessary to attract those who are most talented, still is not enough. In today's schools, teachers still face about 150 children every day. Most of them teach five classes, often requiring two or three separate preparations. They are subjected to endless bookkeeping. If teachers are to derive full benefit from the kind of collaboration with organizations in the community highlighted in this report, more serious attention must be given in the future than in the past to how we organize schools and the demands we place on teachers.

The existing structure of schooling—teaching loads, schedules, the grouping of children, the assignment of teachers, the fact that teachers usually work alone—shape educational activity as much as texts, tests, and state guidelines, severely constraining the limits of educational reform. It has been said more than once in the field of education that nothing can be fixed unless everything is fixed. There is more-than-a-little truth to that observation, and it certainly applies to inter-institutional alliances. To achieve their potential, partnership programs must operate within schools that are organized to enable teachers to develop and take advantage of new connections with the science-rich institutions.

Some Lessons from Successful Partnerships

With the benefit of hundreds of collaborative activities now operating to improve education, some clear and helpful advice about such ventures is beginning to emerge from experienced participants and informed observers. The lessons do not yet constitute an infallible formula for success, of course, but they do provide hints that enhance the chances for success and help avoid serious pitfalls.

Leadership. Not surprisingly, leadership is a key factor. And not surprisingly, either, the person most closely associated with the partnership must be able to articulate a clear vision of the organization's purposes. But in the case of the partnerships we saw, there were additional strengths. First, the person must be very knowledgeable about the community and its resources. Second, he or she (and, in our visits, it more often was a woman than a man) must also have easy access to key figures in each of the participating organizations. Third, if the partnership is spearheaded by a third-party organization, like a local education fund, the person at the top must act in a fashion that may seem to subjugate the needs of his or her own organization to the needs of the other institutions. That is, the third-party agency will thrive only if the participating institutions see the advancement of their own interests as a central element of the partnership.

It is an open question whether or not the third-party agency should take continuing responsibility for operating collaborative programs, and, if it should run some of them, what the mix should be between administering programs and making them possible.

Starting Small. When beginning a partnership program, there is an argument for selecting a niche in the educational system that needs filling, and working to meet that particular need. For example, most of the local education funds were welcomed in their respective communities by initiating minigrants to teachers that were easy to request (compared with school-district procedures) and provided a particularly useful resource.

Collaborative activities to improve science education do not usually *begin* with a focus on wholesale reform. Rather, they provide stimulation and assistance at the margins. System-wide change is formidable. Success is uncertain. The opportunities for controversy are too great; collaboration is predicated on cooperation, not antagonism. Thus, the science collaboratives we saw started with specific projects to build trust and establish the credibility of grass-roots reform.

Indirect support for a gradualist strategy is provided by recent developments in the Boston Compact, a large-scale and highly publicized agreement between the corporate community in Boston and the public schools. The Compact was launched in 1982 at a news conference that brought together the mayor, the school superintendent, the president of the school committee, and representatives of major Boston corporations. Among other things, the Compact assured summer jobs in industry for high school students and permanent jobs for high school graduates. The schools were to reduce drop-out rates and raise standards.

Partly as a result of the fanfare, hope and expectations were high, perhaps unrealistically so. In late 1988, the business community announced that it would not renew the Compact. The reason? According to the corporate spokespersons, the Boston schools had not changed rapidly enough. The reactions from the public schools was sharp and angry. Said John A. Nucci, president of the Boston School Committee, "The business community doesn't have the right to put a gun to the school committee's head and say 'Get these things done or else.'" [51]

Of course, as we have tried to point out, there are potential liabilities to a "start-small" strategy: the collaborative effort may remain forever at the margins, and there is pressing need for systemic reform in science education. Still, since collaboration is relatively new, it seems necessary to build trust among committed partners before expanding, to do one thing better than anyone else, and to work from a well-recognized base of strength.

---

51. See *Education Week*, 9 November 1988, p. 5. For an earlier and rosier view of the Boston Compact, see Eleanor Farrar and Anthony Cipollone, "After the Signing: The Boston Compact 1982 to 1985," in Marsha Levine and Roberta Trachtman (editors), AMERICAN BUSINESS AND THE PUBLIC SCHOOL: Case Studies of Corporate Involvement in Public Education, Chapter 6. New York: Teachers College Press, 1988.

The Organization. Manuel Gomez, Assistant Vice-Chancellor for Academic Affairs at the University of California at Irvine, says, "The more dissimilar the institutions, the greater the prospects for collaboration. The institutions should have common interests but not common goals." He is referring to the STEP program, cited earlier, which is an activity that involves a major research university; a private, four-year college; and a community college in a program that links them to the Santa Ana Unified School District. If the institutions become competitive, as those in the same region with similar goals are likely to be, then collaboration suffers.

He and his STEP colleagues offer additional advice: There should be a long-term commitment from all parties. There should be an administrative structure that formalizes the relationships among the different parties in the collaborative, and that "council" or "steering group" should have representatives designated by the chief executive officers of the participating institutions. The governing group should have the responsibility for approving programs and, ultimately, for institutionalizing the activity.

Implicit in these observations is the assumption that collaboration benefits everyone, and must be seen to benefit everyone. "Many current business/school partnerships seem to rest almost entirely on the interest and goodwill of local business. As a result, many partnerships center only on what businesses can do for schools." [52] Such alliances seem more fragile than those in which the corporate partners are able to point, for example, to the importance of schools to the creation of attractive communities, and therefore to the company's enhanced ability to attract its work force. Similarly, each of the other partners should see how its self-interests are served by cooperation.

---

52. Jeannie Oakes, "Improving Inner-City Schools: Current Directions in Urban District Reform." Center for Policy Research in Education, 1987, p. 47.

With regard to institutionalization, Pittsburgh's Doris Litman points to the advantages of the school district, if not the initiator of the collaborative (as it is in Pittsburgh's case), assuming the role of sustainer of the activity. Her advice seems sensible. First, it is difficult (as Oakes points out [53]) to depend indefinitely on the kindness of strangers. Second, only if the program is lodged in the school district are there likely to be the kinds of fundamental examination that we believe to be necessary of the relationship of the partnership-sponsored activities to the total science program.

It is easier, in many places, to start a collaborative program using the good offices of an agency that is not seen as having a vested interest in ongoing commitments, but if the new arrangements are to be permanent, and once the merits of the collaboration are apparent to all parties, it seems to us highly desirable for the district to take over.

Money. A key factor in local alliances, unsurprisingly, is money. And a central issue in the most-successful programs is how to free them from their extraordinary degree of dependence on the philanthropic foundations. Foundations have been the major force in launching the alliances. They cannot be expected to be the primary agent that keeps them going.

Assistant Vice-President Eugene Cota-Robles of the University of California system says:

> I think the university has difficulty coming to grips with the matter of on-going funds for collaboration, but collaborations will not continue if you depend on external funding. It has to be built into the warp and woof of the institution. The university has to say this is important enough to commit our on-going, "permanent" money, subject to reviews and analysis. This doesn't mean that outside funds cannot be sought . . . .

---

[53] *Ibid.*, pp. 46–49.

> One of the best ways I have found for this [institutional] dedication to occur is to create a faculty advisory committee to an existing [collaborative] operation so that the unit doesn't become isolated and self-perpetuating, but is open to fundamental questioning from the faculty. The advisory committee should include some people from the schools to make sure the university keeps the needs of the schools in the forefront.

Leadership of the Colorado Alliance for Science decided early that the organization could not afford to depend too heavily on such sources. Manert Kennedy, the Alliance's director, spends significant amounts of time trying to secure funds. He writes proposals to private foundations and to the federal government. He tries as hard as anyone else to secure outside money. But he developed a deep aversion to relying too heavily on grants when he was the associate director for many years of the Biological Sciences Curriculum Study (BSCS), one of the large and successful curriculum projects of the 1960s. Such grants are not dependable over the long term, and they do not always reflect the priorities of the local organization.

The Colorado Alliance meets the financial challenge, partly, by a system of membership fees. It receives funds from hundreds of contributors, including corporations, in individual amounts that are small compared to grants from the national foundations. It also receives money from the state and from virtually all the universities. It relies heavily on "in-kind" services.

The Alliance sees benefits other than financial to tapping hundreds of sources for support. Charles Manning, a member of the Colorado Higher Education Coordinating Board, and a strong supporter of the Alliance, says, "When units invest their own funds, they generate stronger commitment." All of Colorado's public universities are members of the Alliance, and Alliance offices are found on each campus. Scores of corporations are also members. Its most recent annual budget was close to half a million dollars.

We believe the Colorado pattern is worth careful examination by other collaborative enterprises. A major policy goal should be to secure funds, even small amounts, from many sources—and, in the process, both to enlist more allies and preserve the ability to respond quickly to unanticipated opportunities.

However, a local alliance needs dependable core funding to strengthen this capability. Ideally, it should come from a single and reliable source. Carolyn C. Chesnutt, SECME's director and an experienced and successful fund-raiser, says, "State funding is the only thing that makes sense." We agree. The State of California appropriates close to $2 million annually for MESA through the University of California and an additional $250,000 through the California State University system. (MESA also received $563,000 in 1988 from corporations, exclusive of "in-kind" services.) North Carolina funds the Mathematics Science Education Network. MESA-type programs are supported by the state in Texas, Washington, and Delaware.

In the opinion of Georgia Tech's engineering dean, William Sangster, the state education agency should be the vehicle for funding organizations like SECME, and there should be formal budgetary relationships between institutions of higher education and the states' departments of education, in the case of programs that are focused on improving the qualifications of elementary and secondary school students for entrance to universities.

We do not see an alternative to significantly increased government support for the kinds of activities described in this volume. State appropriations for core support can mitigate much of the financial uncertainty that now exists in the alliances, as several states have demonstrated in connection with their MESA-type programs.

At the federal level, the National Science Foundation is uniquely positioned to provide leadership from the scientific community, as we have said in the preceding chapter. NSF also can continue to fund specific partnerships on an experimental basis, linking them explicitly to key scientists. And NSF has the lion's share of the funds necessary to support the research, demonstration, and analysis that the country needs to capitalize fully on the local alliance movement.

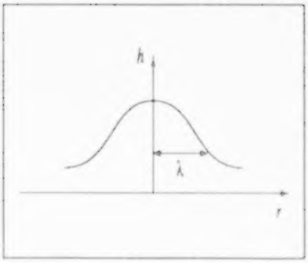
The federal tax advantages to corporations for their gifts of equipment to the schools are also an important factor. The alliances would receive a strong boost if states and municipalities follow the federal lead.

People. One of the most striking benefits of the local alliances is the morale boost it provides for teachers, particularly the most able, in re-linking them with working scientists. Peggy Carnahan is Science Supervisor in the Northside Independent School District, and she chairs the Planning Committee for the San Antonio Science Collaborative. "It is time the science community supports the science teacher," she asserts.

There is little choice in the collaborative activities but to depend on volunteers from the university, government, and corporate worlds, but the benefits of more intensive work with the schools to scientists themselves should be better-known. We have mentioned the importance to some chemists of helping high school students know more about the subject. Many other scientists are beginning to appreciate the importance of public understanding of their activities if their work is to receive sufficient support.

The professional scientific societies have a role to play in broadcasting these messages. The American Chemical Society has long publicized the importance of elementary and secondary education to its members, and has conducted model programs. The Assistant Director of Science and Engineering Education at the National Science Foundation, Bassam Z. Shakhashiri, has conducted annual "Christmas shows" for children at the prestigious National Academy of Sciences, in the spirit of Michael Faraday's London lectures more than a century ago; the demonstrations are attended by many members of the Washington political community, who happen also to be parents of school-age children. The Academy itself sponsors an increasing number of education-related programs, every one of which enjoys help from some of the Academy's distinguished membership. These efforts communicate the importance of education to scientists themselves, as well as to the public.

Along with these activities, corporate "loan" and other programs make it possible for scientists to work intensively with schools. It would help if these programs were better known and if business executives in other firms were urged by corporate leaders to emulate these policies. Tax benefits for these "in-kind" contributions can provide further motivation.


h
λ
r

· 10 ·

POSTSCRIPT: ARE THE TIMES DIFFERENT FOR EDUCATIONAL CHANGE?

If research in education suggests anything, it is that schools do not change easily or quickly. Nor are changes much more than cosmetic if teachers and school administrators do not play a central role. That is not to say that talk about education is not different from one decade to the next. It is. "Joylessness" in schools preoccupied the public in the late 1960s and early 1970s, and many books, articles, and editorials were written on the subject; teachers were oppressing the children, said the authors. The "basics" were stressed a few years later. Before that, it was the "disadvantaged" who received much of the policy attention. And before that, it was Sputnik and the gifted.

While each issue finds a basis in school-house reality, and while there are adjustments within the education system to meet each fresh wave of policy pressure—new courses are often added to the curriculum, for example—the justificatory rhetoric changes much more rapidly than actual classroom practice.

At the outset of the current wave of educational reform, in 1983, some of the education veterans who were familiar with previous attempts to change the schools saw the outcry about declining standards as evidence of one phase of a familiar cycle, with predictable consequences:

1. Schools gradually become more inclusive, admitting and retaining children from a wider band of ability, social class, and handicapping conditions.
2. The public becomes aware of the fact that the newly included group does not fare as well educationally as those whom the schools have served for a longer period—poor minorities in inner-city schools, for example.
3. New attention (often with accompanying resources), is directed toward improvement of education for these children, sometimes redirecting services away from other young people in the system. (The Education of All Handicapped Children Act of 1976, for example.)
4. This is followed by renewed interest in higher standards for everyone, but usually over a more restricted educational range; that is, firmer expectations about the "basics" or about a particular "core" of subjects.
5. Gradually, the curriculum then expands to meet newly emerging and identified needs—for greater economic competitiveness, for example.
6. Schools broaden their missions to serve a still-larger segment of youth (to hold more of those who are dropping out, for example)—back to step 1, in other words.

A believer in this particular cycle theory might consider the present period to reflect many of the features of step 5. Schools, just recently, were emphasizing higher standards in the "basics," but the basics were defined narrowly: essentially the three Rs. Now, the public is worried that children, while needing fundamental skills, require something more to succeed in jobs and to be useful citizens.

If so, then the impetus for change is not likely to last longer than innovation waves of the recent past, with the public hardly pausing to note what has happened, before moving on to some newly identified and popular priority.

However, educational reform efforts of the late 1980s may be motivated, in part, by additional factors—driven to some degree by possibly deeper and less-well-understood impulses; we may be experiencing more than a particular phase of the familiar expansion/standards cycle of educational reform.

Yes, there is the unmistakable, economically driven rhetoric surrounding many public statements of the need for educational change. The educational system is at least partially to blame for America's relative decline, it is said. Even if schools and teachers are not viewed as the causes of low productivity and an unfavorable trade balance, the schools are identified as a key factor in rebuilding industrial competitiveness.

This rationale for educational change seems similar to the reasons heard thirty years ago, immediately after the launching of Sputnik I, for upgrading science programs in the schools. It probably is, and this view must be accommodated in developing strategies for change—and while doing so, teachers and school administrators can try to figure out what major shift comes next, and brace themselves. But there may be something more this time.

Underlying national worries about economic competitiveness, there are concerns about national pride and prestige. But beneath even that there may well be confusion and anxiety about possible loss of a sense of nationhood. The deep interest in improving educational quality, so clear and so uncharacteristically persistent in much of the industrialized world—as well as much of the concern about the teaching of "values"—may be a partial result of the public's perceiving significant links between forging a sense of nationhood and having a strong system of publicly supported education.

Regardless of the saliency of this speculation, why does the driving force for educational change make a difference? If economic anxieties are at the surface of public attention, and this fact is providing impetus for improvement of science education, should not professionals in the field proceed with the task as they did during the intensive attention to science education after the launching of Sputnik I?

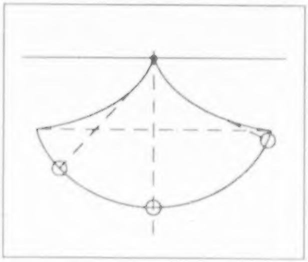
The answer is yes. Dramatic opportunities to engage broad segments of the public in the improvement of education do not arise on a predictable schedule; there is a chance right now to make things better. But there is a qualification. If the public interest in educational content and quality transcends the particular focus in the late 1980s on relative economic decline, then strategies should be developed that respond more deeply than solely to today's most-visible concerns, and that may even take a longer period of time to effect completely.

This point is important. If education is likely to remain high on the political agenda indefinitely, then it would be a strategic error to maximize solely those initiatives that are capable of producing changes in the relatively short term—in this case focusing only on economically related initiatives. The error would be particularly disabling if the economic connection to elementary and secondary education begins to look weaker or less important, as almost certainly will be the case, eventually.

This implication is particularly salient for the kinds of initiatives described cited in this volume: those that arise at grass-roots levels. Even when successful, as those mentioned here are, they usually do not have a profound, short-term effect on the entire system of science education, or even in a single, large school district. However engaging, important, and effective for the people directly involved, the activities described in this report operate, at the moment, at the margins.

But if time is on the side of carefully crafted and site-specific innovation, as may be the case at the threshold of the 1990s, if new participants are gradually drawn into the new programs as they learn about them, then these grass-roots initiatives begin to look more powerful. We then have the luxury of nurturing them and watching them mature. Professionals—teachers and school administrators who have the responsibility for serving the educational needs of young people—can begin committing themselves to an activity that they can have a role in shaping.

Success does have a ripple effect in education, even if one group is unlikely to copy precisely what another does—provided the initiatives are around long enough for people to begin to take notice, exchange ideas, learn from their mistakes, and incorporate the innovation into their regular practices.



· ILLUSTRATIONS ·

p. i Magnetic field and electrical current distribution of a Type II superconductor's vortex.

p. viii Stereographic projection, a method of mapping a sphere onto a plane.

p. xvi Tangent plane of a surface, with its own basis.

p. 16 Tangent vectors on a nonconvex curve.

p. 64 Geodesic constructed in examining the exponential map.

p. 74 Möbius strip with normal vectors.

p. 96 The "monkey saddle," a parameterized surface in two variables given by $x = u$, $y = v$, $z = u^3 - 3v^2u$.

p. 104 Precessing top with angular momentum, force, and torque vectors.

p. 124 SQUID (Superconducting QUantum Interference Device) magnetometer capable of measuring magnetic fields as low as 10^{-7} gauss.

p. 134 Intersecting Fermi spheres of Cooper-paired electrons.

p. 150 Magnetic field amplitude of a Type II superconductor's vortex.

p. 156 Pendulum with cycloidal constraint.

NETWORK PUBLICATIONS
A DIVISION OF ETR ASSOCIATES
SANTA CRUZ, CA

ISBN: 0-941816-86-9